

## Water Heaters

## Workshop Manual

### Thermo 230 Thermo 300 Thermo 350

with control unit 1572  
model .30 and up

### Thermo 230 Thermo 300 Thermo 350

with control unit 1572D  
model .030 and up

### Thermo 231 Thermo 301

model .01 and up

### Thermo Rail



## List of Contents

### 1. Introduction

1.1	Scope and Purpose .....	101
1.2	Applicability of Manual .....	101
1.3	Meaning of Warnings, Cautions and Notes .....	101
1.4	Additional Documentation to be used .....	101
1.5	Safety Information and Regulations.....	101
1.5.1	General Safety Notes .....	101
1.6	Legal Provisions for Installation .....	102
1.7	Corrections and Improvements.....	103

### 2. General Description

2.1	Combustion Air Fan .....	202
2.2	Fuel Pump .....	202
2.2.1	Nozzle block preheater .....	203
2.3	Heat Exchanger .....	203
2.4	Combustion Chamber .....	203
2.5	Control Unit.....	203
2.6	Flame Sensor .....	203
2.7	Igniter Box with Igniter Electrodes .....	203
2.8	Temperature Sensor .....	204
2.9	Temperature Limiter .....	204
2.10	Overheat Thermostat (Thermo 231 and 301 only) .....	204
2.11	Circulation Pump .....	204
2.11.1	Aquavent 5000 (U4814) and Aquavent 5000S (U4854) circulating pumps.....	205
2.11.2	Aquavent 6000C (U4855) and Aquavent 6000SC (U4856) circulating pumps.....	205
2.12	Fuel Filter.....	206

### 3. Functional Description

3.1	Switch On .....	302
3.2	Heating Operation.....	302
3.3	Switch Off .....	303
3.4	Power Save .....	303
3.5	Auxiliary Heating Operation (heaters with control unit 1572D only) .....	303
3.6	Heater Lockout (heaters with control unit 1572D only).....	303
3.7	Switch-off upon Failure (heaters with control unit 1572).....	303
3.8	Switch-off upon Failure (heaters with control unit 1572D) .....	305
3.9	Error Code Output (heaters with control unit 1572D) .....	306

### 4. Technical Data

Electrical components.....	401
Propellant.....	401

**5. Troubleshooting**

5.1	General .....	501
5.2	General Fault Symptoms .....	501
5.3	Fault Symptoms during Functional Checkouts and Error Code Output or Tests with Diagnostic Computer, Components Tester or PC Heater Diagnosis .....	503
5.3.1	General .....	503
5.3.2	Fault Symptoms .....	504

**6. Functional Checkouts**

6.1	General .....	601
6.2	Adjustments .....	601
6.2.1	Adjustment of CO <sub>2</sub> Contents .....	601
6.3	Components Testing .....	602
6.3.1	Temperature Sensor Resistance Check .....	602
6.3.2	Flame Sensor Resistance Check .....	602
6.3.3	Igniter Electrodes Check .....	602
6.3.4	Igniter Box Check .....	603
6.3.5	Fuel Pump Check .....	603
6.3.6	Fan Motor Check .....	604
6.3.7	Solenoid Valve Check .....	604
6.3.8	Nozzle Block Preheater Check .....	604

**7. Circuit Diagrams**

7.1	General .....	701
-----	---------------	-----

**8. Servicing**

8.1	General .....	801
8.2	Heater Servicing .....	801
8.3	Vehicle Servicing .....	801
8.4	Heater Test Run .....	801
8.5	Maintenance .....	801
8.5.1	Inspection and Attachment of the Exhaust Muffler (only heaters from year of production 1996 and up to production date 1996, calendar week 36; 3G.....) .....	801
8.5.2	Burner Head Opening and Closing or Removal and Installation .....	803
8.6	Visual Inspections and Regulations for Installation .....	804
8.6.1	Connection to Vehicle Cooling System .....	804
8.6.2	Connection to Vehicle Fuel System .....	804
8.6.3	Combustion Air Supply .....	806
8.6.4	Exhaust Line .....	806
8.7	Removal and Installation .....	807
8.7.1	Heater, Removal and Installation .....	807
8.7.2	Temperature Limiter, Replacement .....	807
8.7.3	Temperature Sensor, Replacement .....	807
8.7.4	Burner, Replacement .....	807

8.7.5	Igniter Box, Replacement .....	807
8.7.6	Flame Sensor, Replacement .....	808
8.7.7	Combustion Chamber, Replacement .....	808
8.8	First Operation .....	808
8.8.1	Water Circuit, Bleeding .....	808
8.8.2	Fuel Supply System, Bleeding .....	808
<b>9.</b>	<b>Repair</b>	
9.1	General .....	901
9.1.1	Work on Components after Disassembly .....	902
9.1.2	Incorporation of Modifications .....	902
9.2	Disassembly and Assembly .....	906
9.2.1	Temperature Limiter, Replacement .....	904
9.2.2	Temperature Sensor, Replacement .....	904
9.2.3	Burner, Replacement .....	904
9.2.4	Combustion Air Fan, Replacement .....	906
9.2.5	Control Unit, Replacement .....	908
9.2.6	Fuel Pump, Replacement .....	908
9.2.7	High Pressure Nozzle, Replacement .....	908
9.2.8	Igniter Box, Replacement .....	910
9.2.9	Flame Sensor, Replacement .....	910
9.2.10	Heat Exchanger, Replacement .....	912
9.2.11	Combustion Chamber, Replacement .....	912
<b>10.</b>	<b>Packaging, Storage and Shipping</b>	
10.1	General .....	1001
<b>Annex A</b>		
	Heater, Scheduled Maintenance .....	A-2

## **List of Figures**

301	Functional Sequence (heaters with control unit 1572) .....	304
302	Functional Sequence (heaters with control unit 1572D) .....	305
501	General Fault Symptoms .....	501
701	Automatic Control Circuit with Control Unit 1572 and Switch .....	702
702	Automatic Control Circuit with Control Unit 1572 and Timer (Triple Timer) .....	703
703	Automatic Control Circuit with Control Unit 1572D and Switch .....	704
704	Automatic Control Circuit with Control Unit 1572D and Standard Timer.....	705
705	System Circuit Daimler Chrysler Citaro, Ident.-Nr. 67131 .....	706
706	System Circuit Van Hool, Ident.-Nr. 89401 .....	707
707	System Circuit O405 / O407 / O408, Ident.-Nr. 91292.....	708
708	System Circuit MAN, Ident.-Nr. 89404 .....	709
709	System Circuit SETRA, Ident.-Nr. 90972 .....	710
710	Automatic Control Circuit Rail with Control Unit 1572D and Standard Timer and filter heater .....	711
801	Swinging Burner Head open .....	803
802	Example of a Heater Installation in a Passenger Bus .....	805
901	Temperature Limiter, Temperature Sensor and Burner, Replacement.....	905
902	Combustion Air Fan, Replacement .....	907
903	Control Unit and Fuel Pump, Replacement.....	909
904	Igniter Box and Flame Sensor, Replacement .....	910
905	Heat Exchanger and Combustion Chamber, Replacement .....	912

## 1. Introduction

### 1.1 Scope and Purpose

This repair shop manual is intended to support familiarized personnel in the repair of water heaters *Thermo 230, 231, 300, 301 and 350*.

The water heater may only be operated with the specified fuel (Diesel or also fuel oil EL) and the relevant designated type of electrical connection.

### 1.2 Applicability of Manual

This manual is applicable only for heaters identified on the title page. The different appearance of control units (see 2.5) allow to distinguish between model .30 and up with control unit 1572 and the model .030 and up with control unit 1572D.

In combination with control unit 1572D additionally a different type of igniter box is installed (refer to 2.7).

The heaters *Thermo 231 and 301* are variants for vertical installation.

### 1.3 Meaning of Warnings, Cautions and Notes

WARNINGS, CAUTIONS, and NOTES in this manual have the following meaning:

#### **WARNING**

This heading is used to highlight that non-compliance with instructions or procedures may cause injuries or lethal accidents to personnel.

#### **CAUTION**

This heading is used to highlight that non-compliance with instructions or procedures may cause damage to equipment.

#### **NOTE**

This heading is used to highlight and draw specific attention to information.

### 1.4 Additional Documentation to be used

This workshop manual contains all information and procedures necessary for the repair of heaters *Thermo 230, 231, 300, 301 and 350 as well as Thermo Rail*. Operating instructions and installation instructions may be used as complementary information as necessary.

### 1.5 Safety Information and Regulations

The general safety regulations for the prevention of accidents and the relevant operating safety instructions have to be observed at all times.

"General Safety Regulations" beyond the scope of these regulations are detailed in the following.

The specific safety regulations applicable to this manual are highlighted in the individual chapters by Warnings, Cautions, and Notes.

#### 1.5.1 General Safety Notes

**The year of first operation must be permanently marked on the identification label by removing the relevant number of the year.**

The heaters are cleared for heating the vehicle engine and the passenger cabin. The use of the heater in vehicles not subject to the EU Directive 70/156/EEC (e.g. ships) is partly governed by regional regulations. For heaters designed for installation in rail vehicles, type approval has been granted (not for Thermo 231 and 301) by the Federal Railway Authority with the type approval number: EBA 32AZ3/0174/08.

The heater may only be fitted in vehicles or in independent heating systems with a minimum coolant capacity of 10 liters.

The heater may only be installed in motor vehicles or in independent heating systems with a minimum coolant capacity of 6 liters.

The heater must not be installed in the passenger or driver compartments of vehicles. Should the heater nevertheless be installed in such a compartment, the installation box must be sealed tight against the vehicle interior. There must be sufficient ventilation of the installation box from the exterior in order not to exceed a maximum temperature of 85 °C in the installation box. Excessive temperatures may cause malfunctions.

#### **WARNING**

**Due to the danger of poisoning and suffocation the heater must not be operated, not even with timed operation, in enclosed areas such as garages or workshops not equipped with an exhaust venting facility.**

At filling stations and fuel depots the heater must be switched off to prevent explosions.

## CAUTION

Where flammable fumes or dust may build up (e.g. in the vicinity of fuel, coal, wood, cereal depots, or similar installations) the heater must be switched off to prevent explosions.

The heater must not be operated near flammable materials such as dry grass and leaves, cardboard boxes, paper, etc.

In the vicinity of the water heater a temperature of 110 °C (storage temperature) must not be exceeded under any circumstances (e.g. during body paint work).

A violation of this temperature limit may cause permanent damage to the electronics.

When checking the cooling water level proceed in accordance with the vehicle manufacturer's instructions. The water in the heating circuit of the heater must contain a minimum of 10% of a quality brand anti-freeze.

Additives in the heating circuit must not affect metals, plastics and rubber and must leave no deposits.

The opening pressure in the vehicle cooling system - normally indicated on the radiator filler cap - must be between 0.4 and 2.0 bar above operating pressure (also applicable to separate heating circuits).

## 1.6 Legal Provisions for Installation

With effect from 4/03, Type Approvals pursuant to EC Directives 72/245/EEC (EMC) and 2001/56/EC (Heating Systems) were granted for the heaters Thermo 230 / Thermo 231 / Thermo 300 / Thermo 301 / Thermo 350 with the following EC Type Approval Numbers:

e1\*72/245\*95/54\*1010\*--

e1\*2001/56\*0007\*-- for Thermo 230

e1\*2001/56\*0008\*-- for Thermo 300

e1\*2001/56\*0009\*-- for Thermo 350

e1\*2001/56\*0010\*-- for Thermo 231

e1\*2001/56\*0011\*-- for Thermo 301

Up to 4/03, General Design Certifications existed for these heaters.

Installation is governed above all by the provisions in Annex VII of Directive 2001/56/EC.

## NOTE:

The provisions of these Directives are binding within the territory governed by EU Directive 70/156/EEC and should similarly be observed in countries without specific regulations.

(Extract from Directive 2001/56/EC Annex VII)

1.7.1. A clearly visible indicator within the user's field of vision must show when the heater is switched on or off.

## NOTE:

For further notes and provisions relating to the installation of the heater in vehicles, refer to the installation instructions.

## IMPORTANT

Failure to follow the installation instructions and the notes contained therein will lead to all liability being refused by Spheros. The same applies if repairs are carried out incorrectly or with the use of parts other than genuine spare parts. This will result in the invalidation of the type approval for the heater and therefore of its homologation / EC type licence.

Installation Instructions for Spheros fuel tanks for the fuel supply of water heaters in vehicles:

- in busses and trains the installation is not permitted in the passengers' or driver's compartment.
- the fuel filler neck must not be located in the passengers' or driver's compartment of any vehicle.
- fuel containers must either be equipped with a vent cap or any other type of ventilation (vent line).

Only vent caps in accordance with DIN 73400 may be used. All fuel containers offered in the Spheros Accessories Catalogue are suitable for a maximum operating pressure of 0.15 bar overpressure.

All fuel containers offered in the Spheros Accessories Catalogue are subjected during manufacture to individual pressure testing with at least 0.3 bar overpressure.

- The operational state of the heater, i.e. at least an indication "on" or "off" must be easily and clearly visible.

For heaters in vehicles not ruled by the EU Directive but other regulations, the acceptance by the relevant authority is required as applicable.



## **1.7 Corrections and Improvements**

Deficiencies, improvements, or proposals for correction of this workshop manual are to be mailed to:

Spheros GmbH  
Friedrichshafener Straße 9 - 11  
D-82205 Gilching  
Telefon: +49 (0)8105 7721 887  
Telefax: +49 (0)8105 7721 889

[www.spheros.de](http://www.spheros.de) / [service@spheros.de](mailto:service@spheros.de)



## 2 General Description

The water heaters Spheros *Thermo 230, 231, 300, 301* and 350 are used in combination with the vehicle's own heating installation to

- heat the passenger compartment
- defrost the windscreen
- preheat water-cooled engines

The heaters *Thermo 231* and 301 are variants for vertical installation. The difference in appearance are the different identification label and the Z profiles on the installation interface.

The water heater operates independent from the vehicle engine and is connected to the vehicle cooling system, the fuel system and the electrical system.

The heater designed to the heat exchanging principle operates intermittently controlled by the temperature sensor.

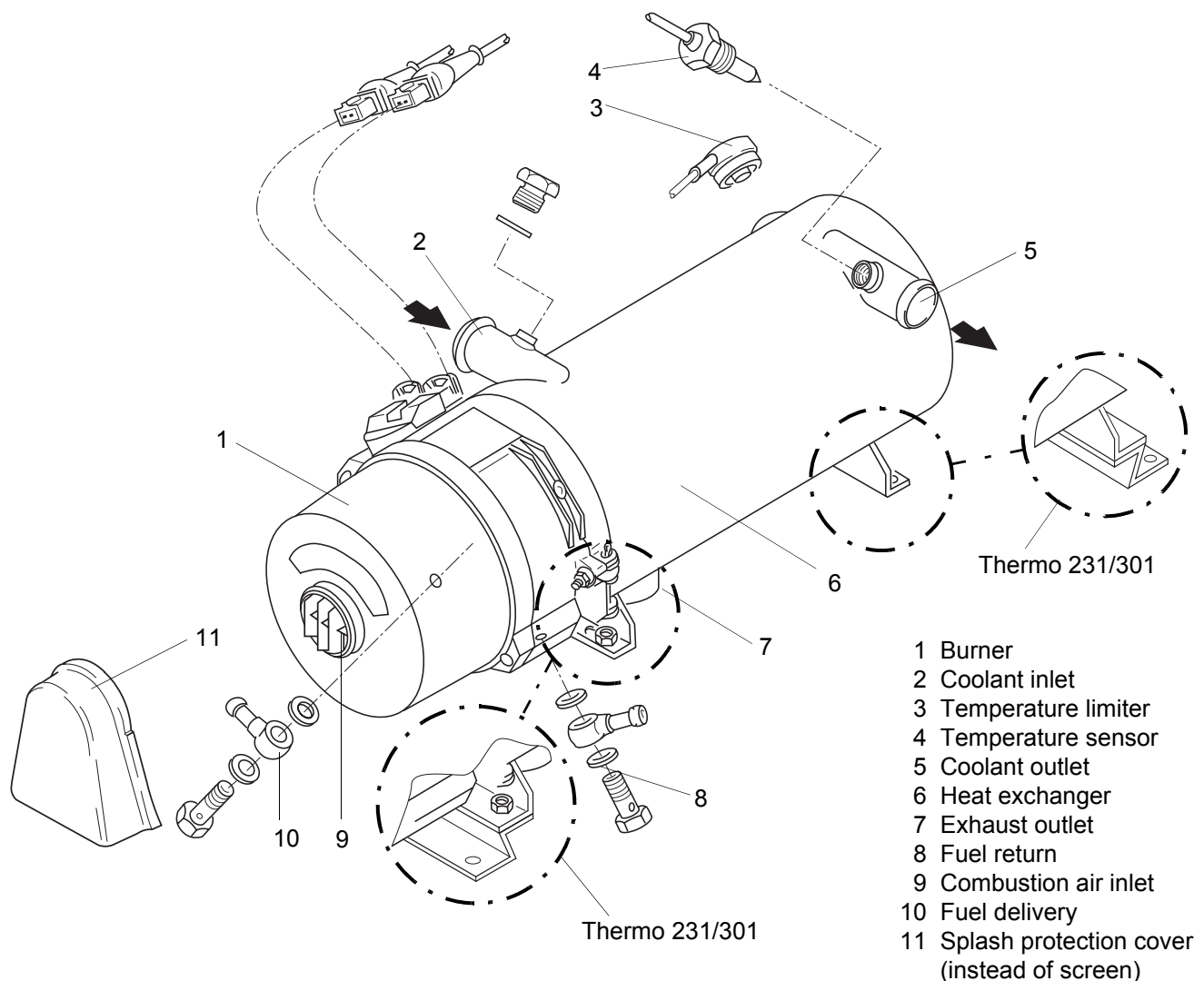
The heaters *Thermo 230, 231, 300, 301* and 350 basically consist of

- the combustion air fan
- the fuel pump with nozzle block and nozzle
- the heat exchanger and
- the combustion chamber
- the igniter box with igniter electrodes

For control and monitoring the heater includes

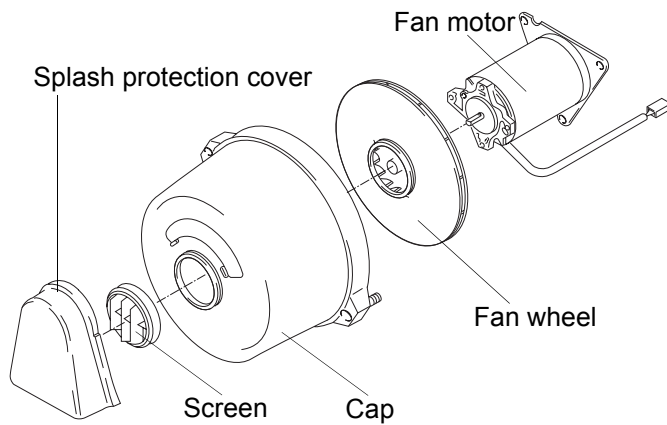
- a control unit
- a flame sensor
- a temperature sensor
- a temperature limiter
- a temperature limiter without reset button for *Thermo 231 and 301 and the Rail variant . 126.*

An external circulating pump is installed inside the vehicle, or, in the case of compact units, directly at the heater.



### 2.1 Combustion Air Fan

The combustion air fan supplies the air required for combustion from the combustion air inlet to the combustion chamber.

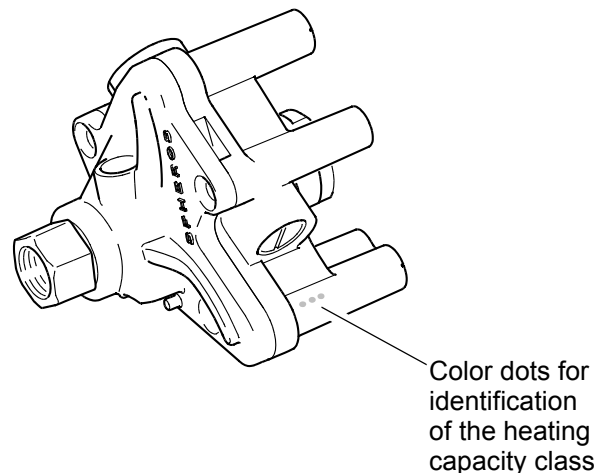
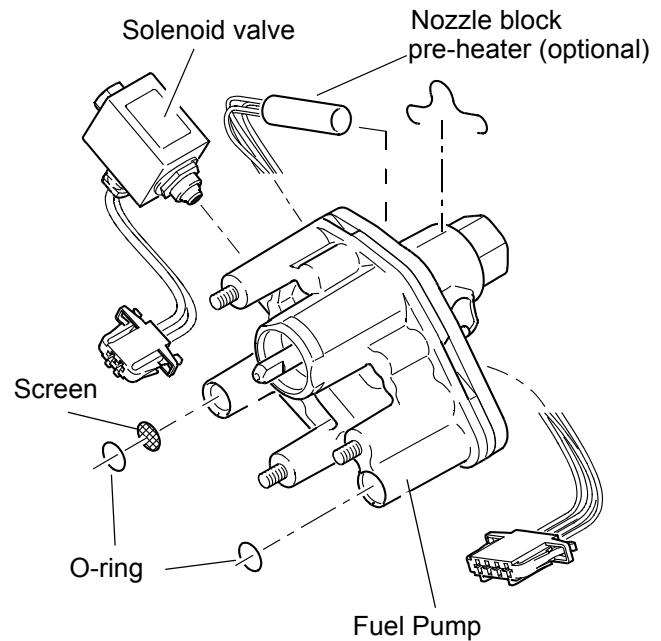


The fan consists of a fan motor with fan wheel. Air is taken in through a splash protection cover or a screen and the cap. The heaters *Thermo 231* and *301* are provided with a splash protection cover only.

### 2.2 Fuel Pump

The fuel pump is responsible for fuel supply. The pump is driven by the burner motor via a coupling. Fuel is compressed in the fuel pump to approx. 10 bar and atomised via the atomiser nozzle. The solenoid valve integrated into the fuel pump opens and closes the fuel supply to the atomiser nozzle. Three different fuel pumps are assigned to the different heating capacity classes of the Thermo series. These are identified by the heating capacity class specification as well as colour dots:

- 16 KW: 1 color dot
- 23-35 KW: 2 color dots
- 40 KW: 3 color dots



The fuel pump can be used in dual-line operation (fuel supply and return line).

If the heater is operated with

- a long fuel supply line
- check valves in the fuel supply and return line
- a fuel filter in the fuel supply line
- single-line operation

the fuel supply line must be filled prior to first heater start-up.

### 2.2.1 Nozzle block preheater

At extremely low temperatures malfunctions may occur without a nozzle block preheater.  
At a temperature of  $< 0^{\circ}\text{C}$  a thermostat activates the heater cartridge in the nozzle block. The heating period depends on the heat reflected within the combustion chamber. Preheating is deactivated when the thermostat ambient temperature is  $+8^{\circ}\text{C}$ .

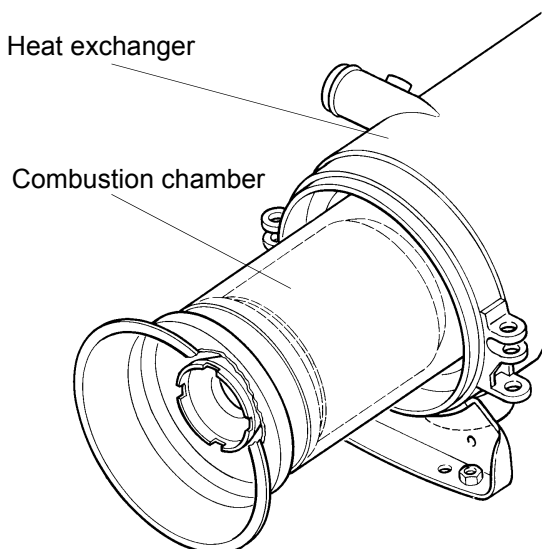
If the heater is not equipped with a nozzle block preheater a retrofit is possible.

### 2.3 Heat Exchanger

The heat exchanger transfers the heat generated by combustion to the coolant circuit.

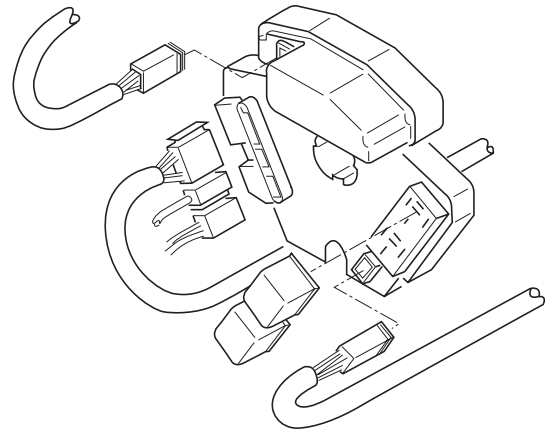
### 2.4 Combustion Chamber

The fuel/air mix is dispersed in the combustion chamber for combustion to heat the heat exchanger.

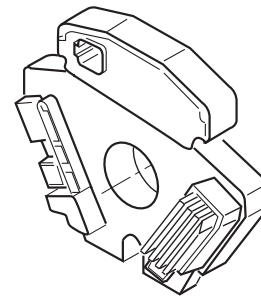


### 2.5 Control Unit

The control unit 1572 or 1572D is the central component to ensure controlled operation and monitoring of combustion. If the heater has a control unit 1572 installed, a retrofit of control unit 1572D is possible (see Section 9).



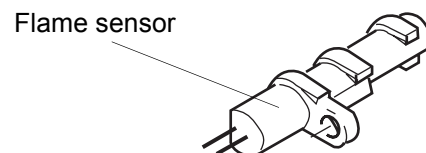
Control Unit 1572



Control Unit 1572D

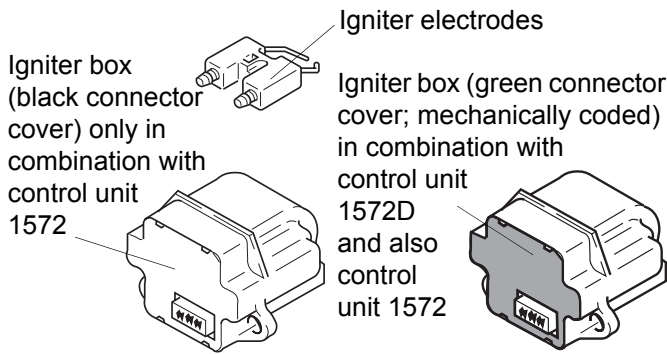
### 2.6 Flame Sensor

The flame sensor continuously monitors the flame condition during operation. The flame sensor is a photo transistor changing its resistance depending on the flame intensity. The signals are supplied to the control unit for processing.



### 2.7 Igniter Box with Igniter Electrodes

The igniter box generates the high voltage for igniting the fuel/air mix by a high voltage ignition spark across the electrodes.

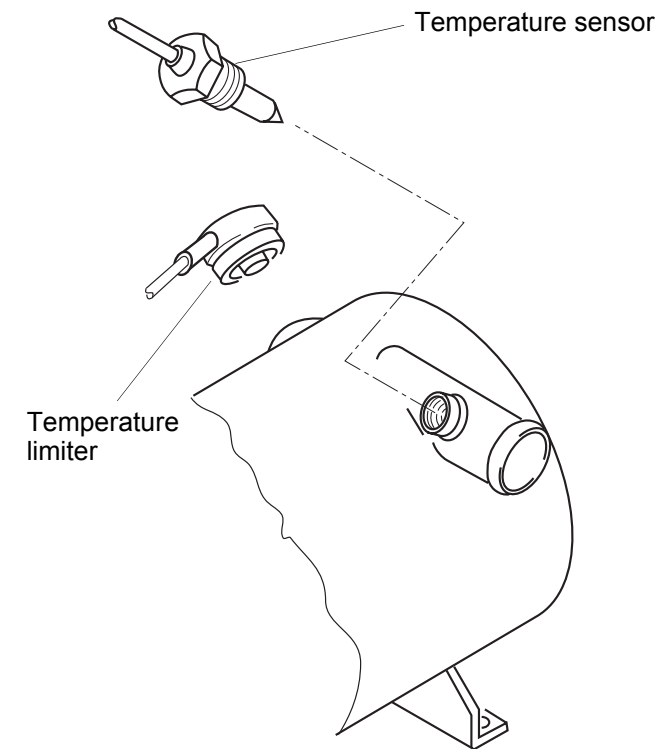


2.8 Temperature Sensor

The temperature sensor senses the coolant temperature at the heat exchanger outlet as an electrical resistance. This signal is supplied to the control unit for processing.

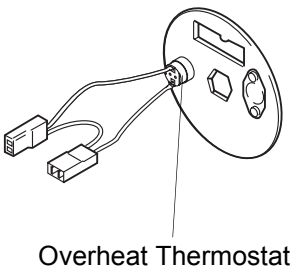
2.9 Temperature Limiter

The temperature limiter (bimetal) protects the heater against undue high operating temperatures. The temperature limiter can be reset manually. The temperature limiter responds at a temperature in excess of 125°C to switch off the heater. In the case of Thermo 231 and 301 as well as the Rail variant .126, the temperature limiter will trip at a temperature in excess of 105°C. After the temperature has dropped, an automatic reset will occur.



2.10 Overheat Thermostat for burner (Thermo 231 and 301 only)

The overheat thermostat is screwed onto the disk and electrically connected to the solenoid valve of the fuel pump. When the burner overheats the thermostat causes an error lockout.

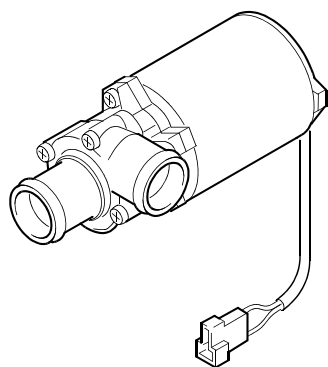


2.11 Circulation Pump

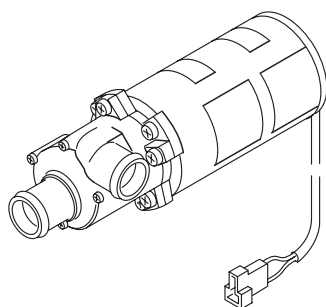
The externally mounted circulation pump ensures proper coolant circulation in the vehicle and heater circuit. Depending on the application, the circulating pump is switched on via the control unit or directly via the vehicle electrical system and operated during the entire heater operation duration. The heaters can be operated with the circulation pumps Aquavent 5000 (U4814), Aquavent 5000S (U4854), Aquavent 6000C (U4855) or Aquavent 6000SC (U4856).

Circulating pump	Delivery rate l/h	Rated voltage V =	Operating voltage range V =	Rated power consumption W	Weight kg
U 4814 Aquavent 5000	5000 (against 0,2 bar)	12 or 24	10...14 or 20...28	104	2,1
U 4854 Aquavent 5000S	5000 (against 0,2 bar)	24	20...28	104	2,2
U 4855 Aquavent 6000C	6000 (against 0,4 bar)	24	20...28	210	2,4
U 4856 Aquavent 6000SC	6000 (against 0,4 bar)	24	20...28	210	2,5

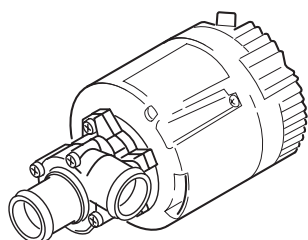
The circulating pump fuse may never be pulled, while the pump is running, and may not be replaced, when the pump is switched on.



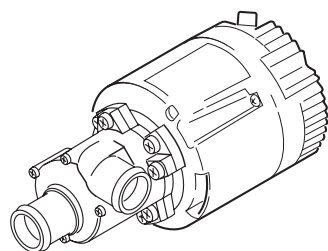
Aquavent 5000  
(U4814)



Aquavent 5000S  
(U4854)



Aquavent 6000C  
(U4855)



Aquavent 6000SC  
(U4856)

### 2.11.1 Aquavent 5000 (U4814) and Aquavent 5000S (U4854) circulating pumps

The Aquavent 5000 (U4814) and 5000S (U4854) circulating pumps are equipped with a brush motor.

#### NOTE

Aquavent 5000 (U4814) with floating-ring type shaft seal.  
Aquavent 5000S (U4854) uncoupled by a magnet (no seal)

#### ATTENTION

The circulating pump motor **is not equipped with an internal inverse-polarity protection.**

### 2.11.2 Aquavent 6000C (U4855) and Aquavent 6000SC (U4856) circulating pumps

The Aquavent 6000C (U4855) and Aquavent 6000SC (U4856) circulating pumps are equipped with a brushless motor.

#### NOTE

The Aquavent 6000C (U4855) has a floating-ring type shaft seal.

The Aquavent 6000SC (U4856) is equipped with a magnetic coupling (no seal).

#### Soft start

The circulating pump motor starts slowly and gently. Max. rotational speed is only reached after approx. 5 seconds.

#### Protection against dry running

Protection against dry running is integrated into the circulating pump motor.

If the circulating pump motor consumes within a time period of approx. 45 minutes significantly less current, dry running is detected. The circulating pump motor is switched off.

After approx. 2 minutes and circulating pump motor reactivation, the operation can be continued.

#### Blocking protection

If the pump wheel is blocked, the motor will be switched off via the error mode directly prior to standstill of the pump wheel.

#### Overload protection

Overload protection is activated after the soft start is completed. The current consumption will be limited.

In case of hydraulic overpressuring of the circulating pump, the circulating pump motor will not be damaged.

#### Fehlermodus

In case of malfunctions the circulating pump motor is switched off via the error mode. After approx. 5 seconds the error mode switches the circulating pump motor into energy-saving sleep mode.

#### Sleep mode

In sleep mode internal electronics consumers of the circulating pump motor are switched off.

#### Reactivation of the circulating pump motor

It is possible to reactivate the circulating pump motor from sleep mode. For this purpose the power supply is disconnected for > 2 min. After the power supply is reconnected, the circulating pump motor restarts in soft-start mode.

#### Inverse-polarity protection

The circulating pump motor **is not equipped with an internal inverse-polarity protection.**

**2.12 Fuel Filter**

At compact devices of the series 230/300/350.126 and .190 *Rail* an optional heatable fuel filter is provided, as an additional option also for .124 and .155 *Rail*.

If the electrical filter heating is hooked-up, the temperature switch turns the integrated filter heating

on at  $\leq 0,5 \pm 2,5$  °C and

off at  $\geq 5,5 \pm 2,5$  °C fuel temperature.



### 3. Functional Description

Activation and deactivation is by means of a

- switch
- timer
- air conditioning

dependent on the type of installation.

For monitoring operation at least an operating indicator light is provided.

Switch off releases a run-down procedure (see "Switch off").

The heaters may be

- operated with power save for reduced fuel consumption (see circuit diagram)
- equipped or retrofitted with a nozzle block preheater for extreme low temperatures.

#### Heaters with control unit 1572D only

When connecting terminal +61 the heaters may operate in the auxiliary heating mode of operation.

#### Switching thresholds

Control device	Ident. No. 63482E Ident. No. 97806B Bus	Ident. No. 97810B  Rail Standard	Ident. No. 63859D  Rail J.E.S
<b>Auxiliary heating</b>			
Upper operating point	85°C	85°C	85°C
Lower operating point	78°C	70°C	75°C

<b>Parking heating</b>			
Upper operating point	85°C	80°C	85°C
Lower operating point	70°C	45°C	70°C

<b>Parking heating (economic setting)</b>			
Upper operating point	70°C	20°C	70°C
Lower operating point	55°C	75°C	55°C

<b>Gradient evaluation</b>	Yes	Yes	Yes
<b>Hysteresis adaption</b>	Yes	Yes	Yes

#### Switching thresholds for Thermo xxx Rail

Version Thermo xxx*	230.040 „VOSSLOH“	230.056 350.056 „VOSSLOH“	300.124	xxx.126	300.155 350.155	350.190
Scope of delivery		973 13A thru 973 13D			90 162 37x 90 162 36A 90 162 35A	90 210 12B
Heater						
Control device	638 59D	679 81C		987 10x		978 04x

<b>Auxiliary heating</b>				
Upper operating point	85°C	85°C	85°C	85°C
Lower operating point	75°C	72°C	70°C	70°C

<b>Parking heating</b>			Preheating	
Upper operating point	85°C	75°C	60°C	60°C
Lower operating point	70°C	60°C	45°C	45°C

<b>Parking heating (economic setting)</b>			keeping frost-free	
Upper operating point	70°C	57°C	20°C	40°C
Lower operating point	55°C	42°C	5°C	25°C

<b>Gradient evaluation</b>	Yes	Yes	Yes	
<b>Hysteresis adaption</b>	Yes	Yes	Yes	

<b>Low voltage threshold</b>				18,5V (20 sec.)
------------------------------	--	--	--	--------------------

\* xxx means 230 or 300 or 350

#### 3.1 Switch On

Upon switch on the operating indicator light goes on. Combustion air fan, fuel pump and circulation pump start operation. (If fitted and temperature is < 0 °C nozzle block preheater is also activated).

After approximately 12 seconds (run-up time) the high voltage igniter spark is available. Approximately 1 second later the solenoid valve in the fuel pump opens and the nozzle sprays fuel into the combustion chamber to be ignited by the igniter spark. A photo control circuit deactivates the igniter box after flame-up.

#### 3.2 Heating Operation

After reaching operating temperature the control unit takes over to provide controlled operation by activation and deactivation of the burner in order to maintain a nearly constant temperature of the heat exchanger (coolant).

The heating operation is terminated as soon as the upper operating point is exceeded. The heater now is in the control idle period. Heater operation is resumed when the temperature drops below the lower operating point.

**Heaters with control unit 1572D only**

**Gradient evaluation**

In case of low coolant flow or poor coolant circuit venting the temperature quickly increases in heating operation. If gradient evaluation exists, the control unit recognises the quick temperature increase and automatically sets the upper switching threshold to a lower value. This prevents residual heat triggering the overheating protection.

**Control idle period**

A rise in temperature above the upper switching point makes the solenoid valve in the fuel pump shut off the fuel supply initiating the run-down. The flame extinguishes, the combustion air fan and the circulation pump however continue their operation. After approximately 90 seconds (120 seconds for heaters with control unit 1572D) run-down is completed with deactivation of the combustion air fan.

The circulation pump remains in operation during the control idle period. The operating indicator light is on.

**3.3 Switch Off**

Switching off the heater stops combustion. The operating indicator light goes out and run-down commences. The combustion air fan and circulation pump are deactivated after approximately 90 to 120 seconds (120 seconds for heaters with control unit 1572D).

Reactivation of the heater during run-down is permitted. The burner immediately resumes operation after the run-up time.

**3.4 Power Save**

With power save on the control temperatures of the heating circuit are kept low. Combustion performance is not reduced.

This results in a reduced heat radiation loss when limited heating performance is required (e.g. in heat hold operation) cutting down fuel consumption.

**3.5 Auxiliary Heating Operation (heaters with control unit 1572D only)**

When terminal +61 is connected and powered (engine is running), the heater operates in the auxiliary heating mode.

The power save mode is during auxiliary heating automatically deactivated by the control device.

The lower temperature threshold for reactivation of the

burner after control idle period is raised above that for normal operation and is automatically shifted up or down dependent on the combustion time of the heater (hysteresis adaptation).

**Hysteresis adaptation (example)**

After the first control idle period, the lower operating point is 78°C.

Combustion operation is started when the temperature falls below this threshold.

The length of combustion time until the upper operating point is exceeded should be 120 seconds.

If combustion lasts more than 120 seconds, the lower operating point is increased by 1 Kelvin, up to max. 80°C.

If combustion time is less than 120 seconds, the lower operating point is lowered by 1 Kelvin, down to minimally 70°C.

**3.6 Heater Lockout (heaters with control unit 1572D only)**

After the heater has performed eight start attempts due to a malfunction or after five subsequent flame-outs the heater enters a lockout and start attempts are suspended. This lockout is superior to the normal error lockout. Unlocking is performed by starting the heater and disconnection of the main power supply of the heater during error run-down.

**3.7 Switch-off upon Failure (heaters with control unit 1572)**

The heater switches off automatically when detecting one of the following malfunctions.

The operating indicator light goes off. Combustion air fan and circulation pump are deactivated after approximately 90 to 120 seconds.

**Malfunctions during switch-on**

- short or open circuit of temperature sensor.
- short or open circuit of flame sensor.
- open circuit of solenoid valve.

**Malfunctions during start-up:**

- flame detected by photo control circuit prior to high voltage igniter spark.
- no flame detected after approximately 25 seconds after heater start.

**Malfunctions during heating operation:**

- low voltage threshold of approximately 20V violated for a duration of 12 seconds.
- no combustion for more than 10 seconds.

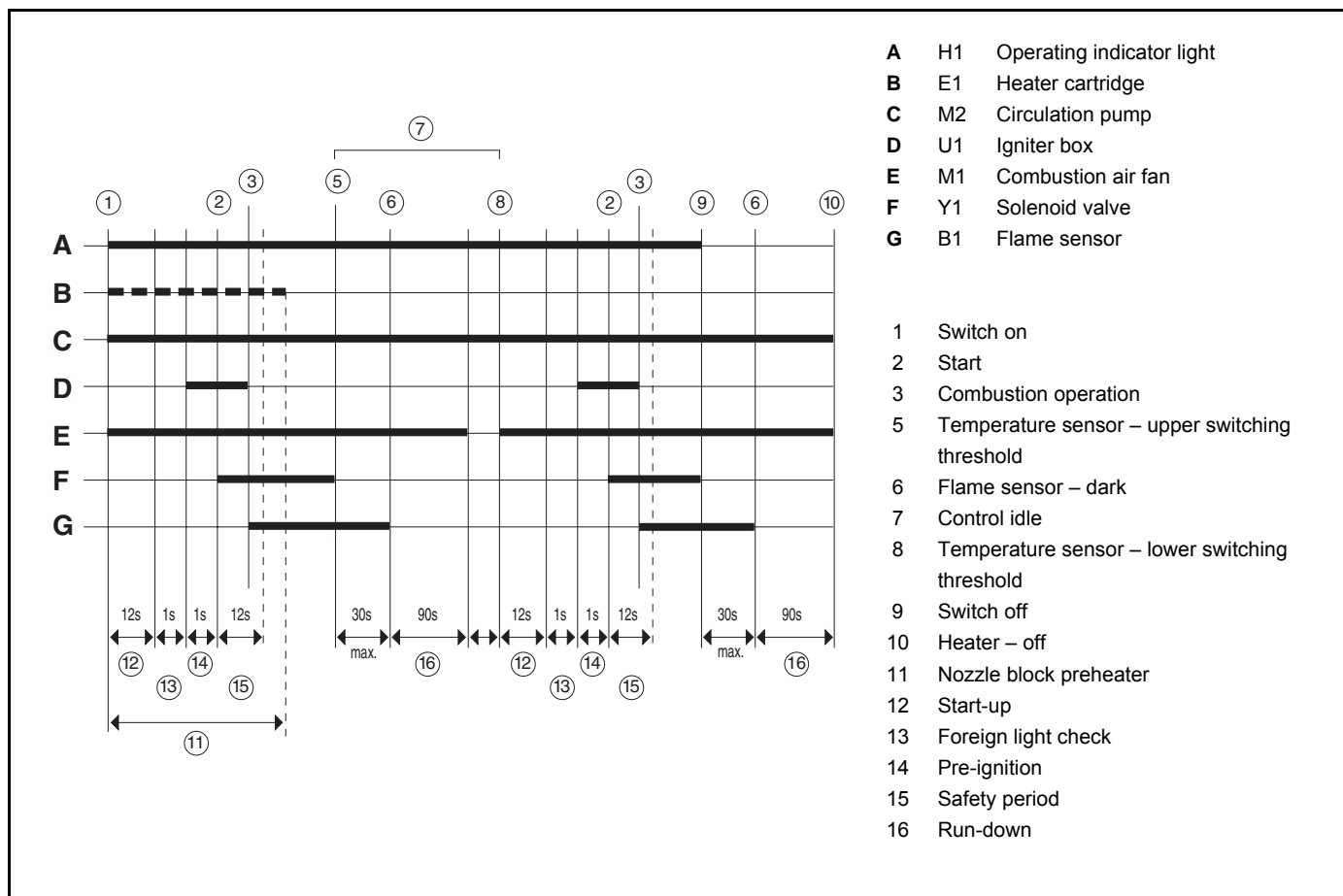


Fig. 301:Functional sequence (heaters with control unit 1572)

- temperature sensor short circuit during control idle.
- temperature sensor open circuit during combustion.
- flame sensor short circuit during combustion.
- solenoid valve short circuit during combustion.

**Malfunctions during run-down:**

Detection of a flame after more than 30 seconds after start of run-down with the circulation pump and combustion air fan maintaining operation for the following 90 seconds.

**Malfunctions by overheating:**

Overheating results in deactivation of the heater by the temperature limiter. After cool down of the unit and correction of the fault the button of the temperature limiter must be reset.

An error reset for a new start standby is achieved by switching the heater off and on again.

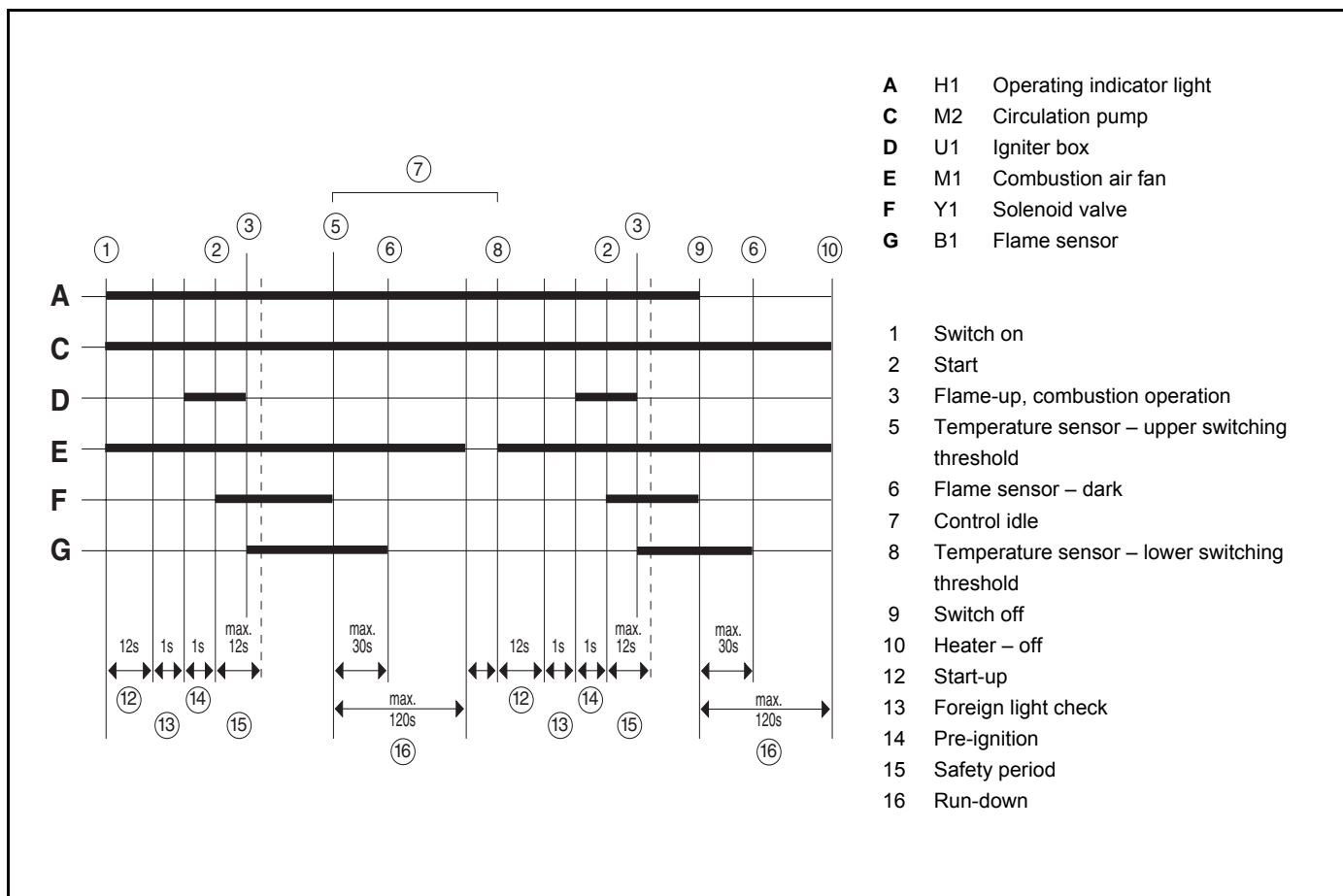


Fig. 302:Functional sequence (heaters with control unit 1572D)

### 3.8 Switch-off upon Failure (heaters with control unit 1572D)

The heater switches off automatically when detecting one of the following malfunctions.

Several subsequent switch-offs due to a malfunction will cause the heater to enter an error lockout condition.

Flash pulses are output via the operating indicator light. The combustion air fan and the circulation pump are switched off after approx. 120 seconds.

#### Malfunctions during switch-on:

Short or open circuit of

- temperature sensor
- flame sensor
- burner motor
- solenoid valve
- igniter box

#### Malfunctions during start-up:

- short circuit of igniter box
- open circuit of igniter box
- flame detected by photo control circuit prior to high voltage igniter spark.
- no flame detected after approximately 25 seconds after heater start.

- short/open circuit or dry run (if programmed) of circulation pump.

When using the circulation pump U 4851 approximately 15 seconds after switch-on the circulation pump is automatically stopped and may only be reactivated after approximately 2 minutes should coolant be missing or the pump wheel be seized.

#### Malfunctions during heating operation:

- low voltage threshold of approximately 21V violated for a duration of 20 seconds.
- no combustion for more than 10 seconds.
- temperature sensor short or open circuit.
- flame sensor short or open circuit.
- solenoid valve short or open circuit.

#### Malfunctions during heating operation: (valid for application Thermo 350.190)

- low voltage threshold of approximately 18,5V violated for a duration of 20 seconds.
- no combustion for more than 10 seconds.
- temperature sensor short or open circuit.
- flame sensor short or open circuit.
- solenoid valve short or open circuit.

#### Malfunctions during run-down:

Detection of a flame after more than 30 seconds after start of run-down with the circulation pump and combustion air fan only maintaining operation for the following 90 seconds.

#### Malfunctions by overheating:

Overheating results in deactivation of the heater by the temperature limiter/thermostat. Dependent on heater configuration:

- the reset button on the temperature limiter must be reset.
- the reset of the thermostat is performed automatically after cool down.

An error reset for a new start standby is achieved by switching the heater off and on again.

#### Malfunctions by overheating of the burner (Thermo 231 and 301):

Overheating of the burner causes the overheat thermostat to initiate an error lockout at 150°C.

The solenoid valve closes, the fuel supply is cut off and a run-down is launched. An auto-reset occurs after cool-down of the thermostat.

### 3.9 Error Code Output (heaters with control unit 1572D)

When equipped with a standard timer an error code readout appears on the display of the timer after a malfunction.

#### NOTE

When the heater is operated by means of a switch the type of error is output during heater run-down via a flash code of the operating indicator light. After five short signals the long flash pulses are counted. The flash pulses correspond to the error number in the following table:

- F 01 no start
- F 02 flame-out \*
- F 03 low voltage or excess voltage
- F 04 foreign light detected during run-up and run-down
- F 05 flame sensor defective
- F 06 temperature sensor defective
- F 07 solenoid valve defective
- F 08 fan motor defective
- F 09 circulation pump defective \*\*
- F 10 temperature limiter defective / overheating
- F 11 igniter box defective
- F 12 error lockout due to repeated malfunction or repeated flame-out (8x no start-up or 5x flame-out)

\* A response of the overheat thermostat will be stored in the control unit as a flame-out (F 02) (*Thermo 231 and 301*).

\*\* The error 09 is indicated only if the heater is equipped with a circulation pump monitoring (see table below).

Table: Programmed SG1572D with integrated circulation pump monitoring

EOL-Data record for SG 1572D			
EOL-Data record	Circulation pump monitoring		Ctr. device programmed
	Yes	No	
63317F			
63860E			
67980D	X		67981D
96774B			
97805C			
97807C	X		97810C
97809C	X		97810C
97811B	X		97812A
97813A			
97815A			

## 4. Technical Data

Where no threshold values are specified technical data are understood to include standard tolerances for heater units of  $\pm 10\%$  at ambient temperature of  $+ 20\text{ }^{\circ}\text{C}$  and at nominal voltage.

### Electrical components

Control unit, fan and circulation pump motors, solenoid valve, igniter box, heater cartridge, nozzle block preheater and timer are 24V components. Temperature limiter, flame sensor, temperature sensor and switches are voltage independent components.

#### NOTE

The allocation of circulation pumps to heater units must be in accordance with coolant resistances.

### Propellant

The suitable propellant is the Diesel fuel specified by the vehicle manufacturer.

Only the type of fuel indicated on the identification plate may be used. Also Diesel fuel with an addition of 5% PME (vegetable oil methyl ester), class EL fuel oils (not fuel oil L) or petroleum may be used if their quality is in accordance with the German standard.

A bad influence caused by additives is not known.

When using fuel out of the vehicle tank the information about additives of the vehicle manufacturer must be observed.

When using fuel out of a separate fuel tank and at temperatures below  $0^{\circ}\text{C}$ , winter Diesel fuel must be used. The use of flow improvers is permitted.

Mixing ratio for separate fuel tank and temperature below  $0^{\circ}\text{C}$ .

Temperature	Winter Diesel fuel	Additive petroleum or petrol
$0\text{ }^{\circ}\text{C}$ to $-20\text{ }^{\circ}\text{C}$	100 %	—
$-20\text{ }^{\circ}\text{C}$ to $-30\text{ }^{\circ}\text{C}$	70 %	30 %
	or special low temperature Diesel fuel	
$-30\text{ }^{\circ}\text{C}$ to $-40\text{ }^{\circ}\text{C}$	special low temperature Diesel fuel or 100 % petroleum	

Heater		Thermo 230	Thermo 231	Thermo 300	Thermo 301	Thermo 350
Type		Thermo 230	Thermo 231	Thermo 300	Thermo 301	Thermo 350
Mark of conformity up to 4/03		~ S230	~ S327	~ S229	~ S328	~ S228
EC type approval number e1*2001/56*		0007*--	0010*--	0008*--	0011*--	0009*--
Heater principle		High pressure atomizer				
Heating flow	KW (kcal/h)	23 (20 000)		30 (26 000)		35 (30 000)
Fuel		Diesel / fuel oil				
Fuel consumption	kg/h	2.9		3.3		3.7
Nominal voltage	V-	24				
Operating voltage	V-	20 ... 28				
Operating voltage (valid for application Thermo 350.190)	V-	19 ... 28				
Nominal power consumption (without circulation pump)	W	65		110		140
Permissible operating ambient temperature range (heater, control unit, circulation pump)	°C	-40 ... +85				
Permissible storage temperature	°C	+110 max.				
Permissible operating overpressure	bar	0.4 ... 2.0				
Heat exchanger capacity	l	1.8				
Minimum capacity of circuit	l	10.00				
CO <sub>2</sub> in exhaust at nominal voltage	Vol.-%	10 ±0.5 related to 500 m above S.L.				
CO <sub>2</sub> in exhaust at nominal voltage (valid for application Thermo 350.190)	Vol.-%	9,2 ... 10,1				
Dimensions heater (tolerance ± 3 mm)	mm mm mm	length 610 width 246 height 220				
Weight	kg	19				



<b>Circulation pump</b>		<b>U 4814 Aquavent 5000</b>	<b>U 4854 Aquavent 5000S</b>	<b>U 4855 Aquavent 6000C</b>	<b>U4856 Aquavent 6000SC</b>
Volume flow	l/h	5000 (against 0,2 bar)	5000 (against 0,2 bar)	6000 (against 0,4 bar)	6000 (against 0,4 bar)
Nominal voltage	V =	12 or 24	24	24	24
Operating voltage range	V =	10...14 / 20...28	20...28	20...28	20...28
Nominal power consumption	W	104	104	210	210
Dimensions		Lenght 230 Width 100 Height 103	Lenght 249 Width 100 Height 105	Lenght 226 Width 115 Height 118	Lenght 231 Width 115 Height 118
Weight	kg	2,1	2,2	2,4	2,5

**Optional Fuel Filter Heater**

<b>Filter Heater</b>		
Nominal power consumption	W	240
Nominal voltage	V -	24
Switch-on point	C°	0,5 ± 2,5
Switch-off point	C°	5,5 ± 2,5



## 5 Troubleshooting

### 5.1 General

This section describes troubleshooting procedures for the heaters *Thermo 230, 231, 300, 301* and *350*.

#### CAUTION

Troubleshooting requires profound knowledge about components and their theory of operation and may only be performed by trained personnel.

In case of doubt functional interrelations may be derived from Sections 2 and 3.

#### CAUTION

Troubleshooting is normally limited to the isolation of defective components.  
The following possible causes for trouble have not been taken into consideration and must always be excluded as a possible cause for malfunction:

**corrosion on connector**  
**loose contact on connector**  
**wrong crimping on connector**  
**corrosion on wiring and fuses**  
**corrosion on battery terminals**

After any fault correction a functional checkout in the vehicle has to be performed.

### 5.2 General Fault Symptoms

The following table (Fig. 501) lists possible fault symptoms of general nature.

Symptom	Probable Cause
<b>Fault in electrical system</b>  Operating indicator light is not on, no heater operation.  Fuse F2 blows.  Fuse F3 blows.  Normal heater operation, operating indicator light is out.	<ul style="list-style-type: none"> <li>no power supply</li> <li>fuses</li> <li>wiring to terminals of connector A of control unit.</li> </ul> Short circuit in circulation pump or in wiring to heater.  Short circuit in wiring to heater/motor/nozzle block preheater (if installed).  Operating indicator light defective or wiring to light open or shorted.
<b>Fault in water system</b>  Circulation pump not operating (U 4851 and Aquavent 6000 S only)	<ul style="list-style-type: none"> <li>Failure mode activated</li> </ul> The failure mode switches the motor off in case of malfunctions. After approx. 5 sec the failure mode switches the motor to the power saving sleep mode.  In the sleep mode the internal consumers of the motor electronics are switched off. The power consumption in this mode then amounts to < 2 mA.  The motor can be reactivated out of the sleep mode by disconnection of the power supply for approx. 2 minutes. After power reconnection the motor will again run up with a soft start.

Fig. 501 General Fault Symptoms (Sheet 1 of 3)

Symptom	Probable Cause
Heater operation stops because heat exchangers connected do not dissipate enough heat.	<p><u>Rate of flow too low, because</u></p> <ul style="list-style-type: none"> <li>• air in heater, in heat exchangers or in system sections.</li> <li>• cocks (flow regulator) throttled, contaminated or closed.</li> <li>• contamination in system, e.g. in areas of restricted flow.</li> <li>• circulation pump rate of delivery insufficient (air in pump housing). wrong sense of rotation – check wiring colors (black + / brown –).</li> <li>• not enough anti-freeze.</li> <li>• excessive system resistance (especially high when cold).</li> <li>• circulation pump defective.</li> </ul> <p><u>Heat exchanger dissipate not enough heat, because</u></p> <ul style="list-style-type: none"> <li>• air in heat exchangers or in system sections.</li> <li>• contaminated heat exchanger surfaces (external).</li> <li>• insufficient air intake or exit.</li> <li>• fan: rate of delivery low / wrong sense of rotation / resistance too high.</li> <li>• too much anti-freeze.</li> <li>• heat exchanger of too low capacity.</li> </ul>
<p><b>Rough calculation of rate of flow</b></p> <p>Rate of flow in [l/h] = <math display="block">\frac{\text{heat flow [kW] acc. to ident. label}}{\text{temperature difference } \Delta t \text{ in [K] or [}^{\circ}\text{C] measured between heater water inlet and outlet (e.g. with contact thermometer)}} \times 860</math></p>	
<p><b>Fault in fuel supply</b></p> <p>No fuel delivery to heater.</p>	<ul style="list-style-type: none"> <li>• fuel tank empty.</li> <li>• kinked, closed, contaminated or leaking lines.</li> <li>• paraffin deposits or water captured in fuel filter or fuel lines.</li> <li>• vent in tank clogged.</li> <li>• fuel lines interchanged.</li> <li>• fuel filter contaminated.</li> <li>• fuel screen in pump contaminated.</li> </ul>

Fig. 501 General Fault Symptoms (Sheet 2 of 3)

Symptom	Probable Cause
<b>Wrong combustion</b>  CO <sub>2</sub> value cannot be set to rated value, combustion irregular.	<ul style="list-style-type: none"> <li>• air bubbles in suction line (suction line leaking).</li> <li>• fuel filter contaminated or leaking.</li> <li>• fuel system integration leak (suction height, low pressure in tank); observe installation instructions.</li> <li>• fuel pump defective (pump pressure).</li> <li>• return line throttled.</li> <li>• filter screen in pump contaminated.</li> <li>• O-ring sealing on fuel pump no longer effective (ageing)</li> <li>• nozzle jet defective.</li> <li>• combustion air or exhaust lines throttled or closed.</li> <li>• fan motor speed too low.</li> </ul>

Fig. 501 General Fault Symptoms (Sheet 3 of 3)

### 5.3 Fault Symptoms during Functional Checkouts and Error Code Output or Tests with Diagnostic Computer, Components Tester or PC Heater Diagnosis

#### 5.3.1 General

##### Error Code Output

###### NOTE

Only heaters with a control unit 1572D provide an error code output.

When equipped with a standard timer an error code readout is available after a malfunction on the display of the timer.

When the heater is operated by means of a switch a coded flashing of the operating indicator light during run-down of the heater or until switch-off indicates the type of error (see 3.9).

##### Diagnostic Computer

###### NOTE

Checks with the diagnostic computer may only be performed on heaters equipped with control unit 1572.

By use of the diagnostic computer heaters may be checked in the vehicle. The following tests are available:

- indication of measured values: water temperature, control unit supply voltage, flame sensor bright/dark.
- indication and erasure of faults stored in the control unit.

Operation of the diagnostic computer is menu controlled by means of four push button switches.

For details refer to operating instructions for "Diagnostic Computer".

##### Components Tester

###### NOTE

Checks with the components tester may only be performed on heaters equipped with control unit 1572.

Using the components tester several types of faults and component malfunctions may be analyzed in the vehicle. The test of the individual components with the components tester is not intended. Faults like short or open circuits may be detected with the components tester but cannot be localized.

For details refer to operating instructions for "Components Tester".

##### PC Heater Diagnosis

By use of the PC heater diagnosis heaters (with control unit 1572 or 1572D) may be tested in the vehicle.

For details refer to operating instructions for "PC Heater Diagnosis".

## 5.3.2 Fault Symptoms

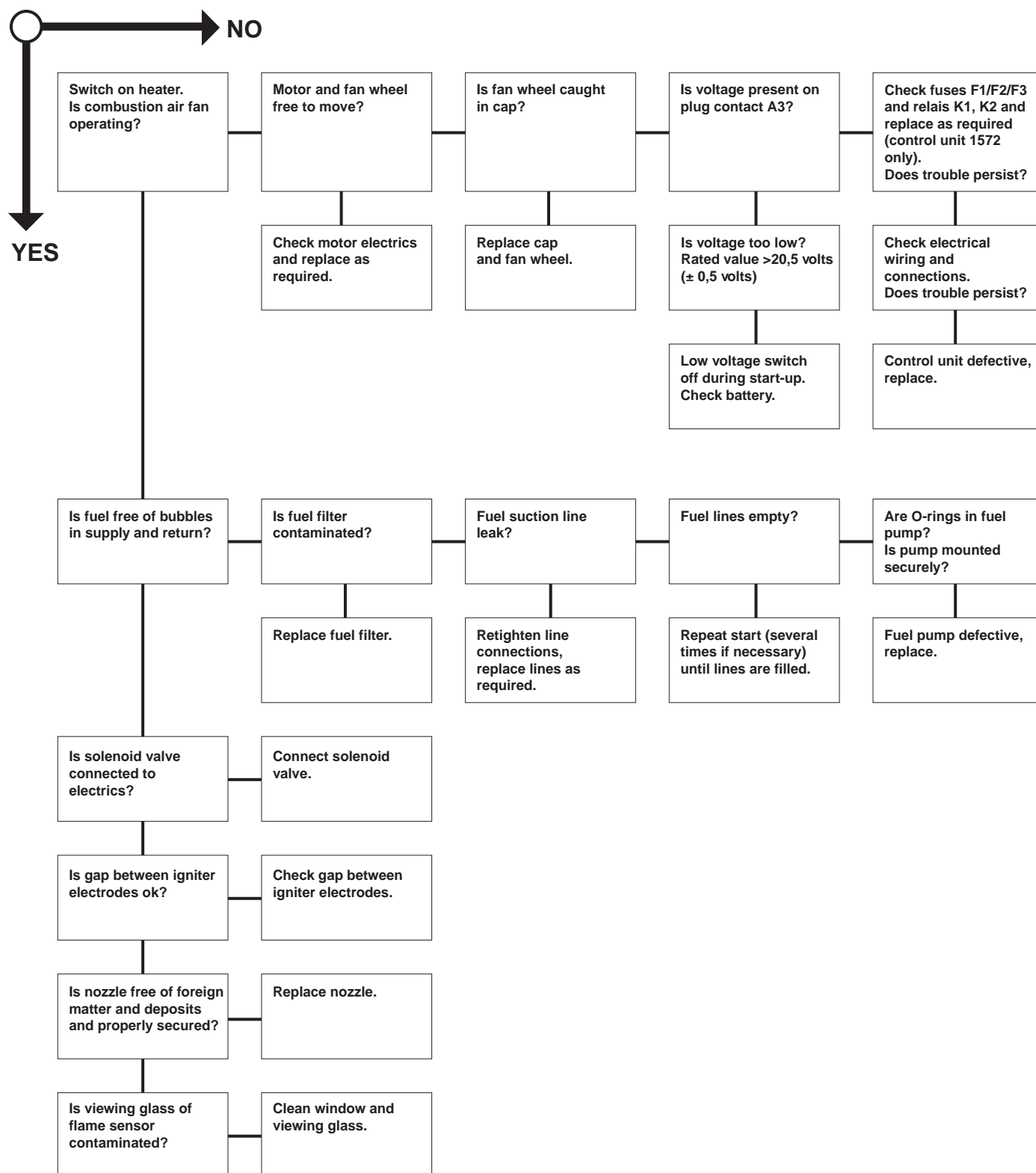
## 5.3.2.1 Fault Symptom "No Start"

**NOTE**

Heaters with control unit 1572D:

If the heater performs 8 consecutive attempts to start due

to a malfunction, the heater enters an error lockout and stops any further attempts to start. This error lockout is superior to the normal error lockout condition. The error lockout reset is achieved by switching the heater on and disconnection of the heater power supply during run-down.



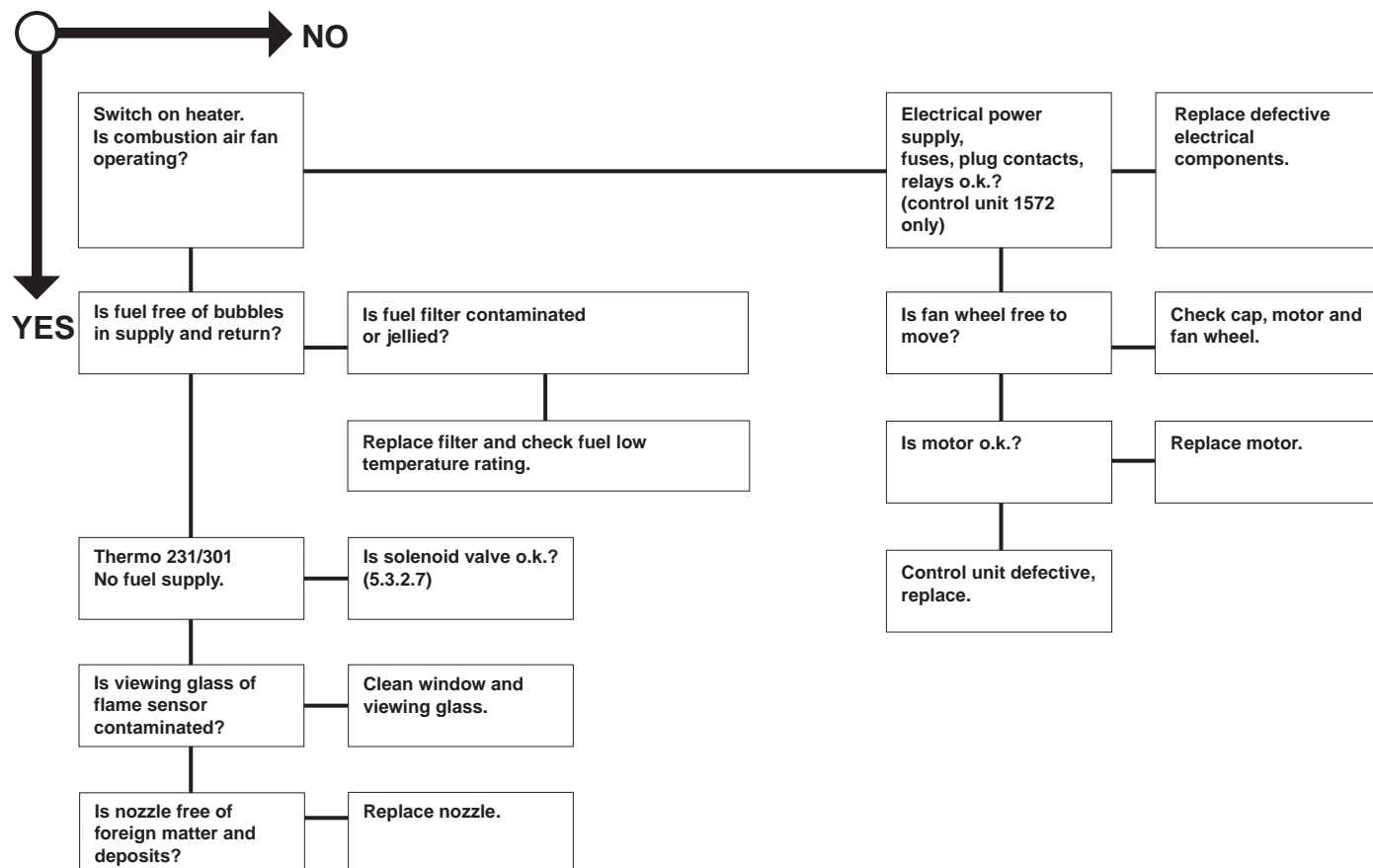
## 5.3.2.2 Fault Symptom "Flame-out"

**NOTE**

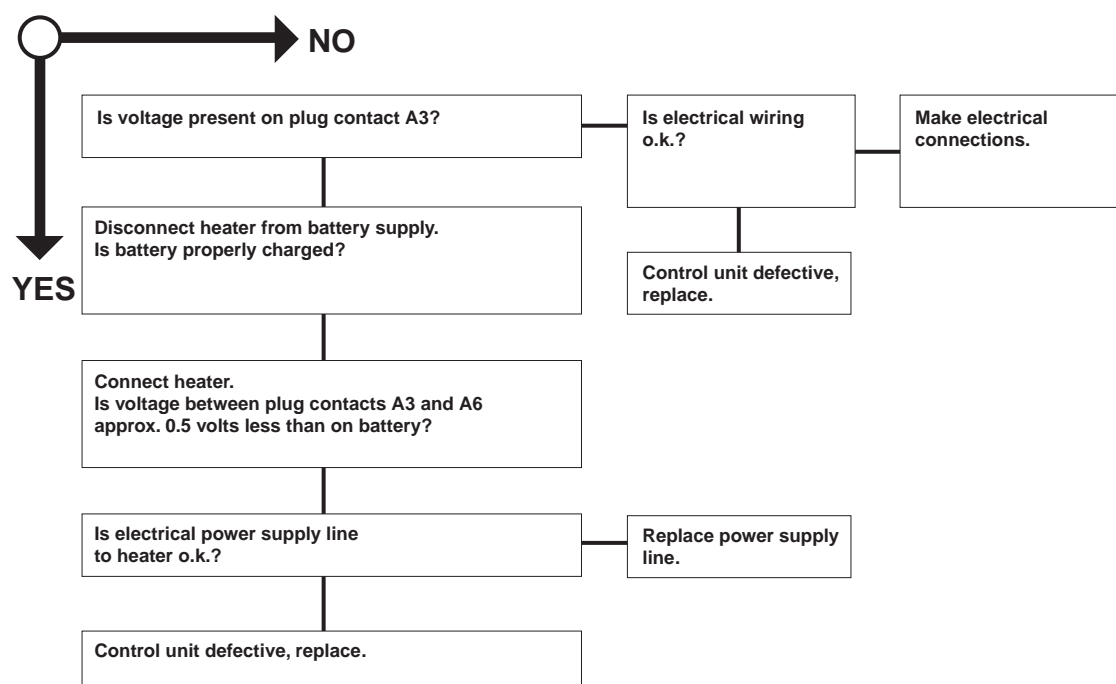
Heaters with control unit 1572D:

If the heater performs 5 consecutive attempts to start due to a malfunction, the heater enters an error lockout and

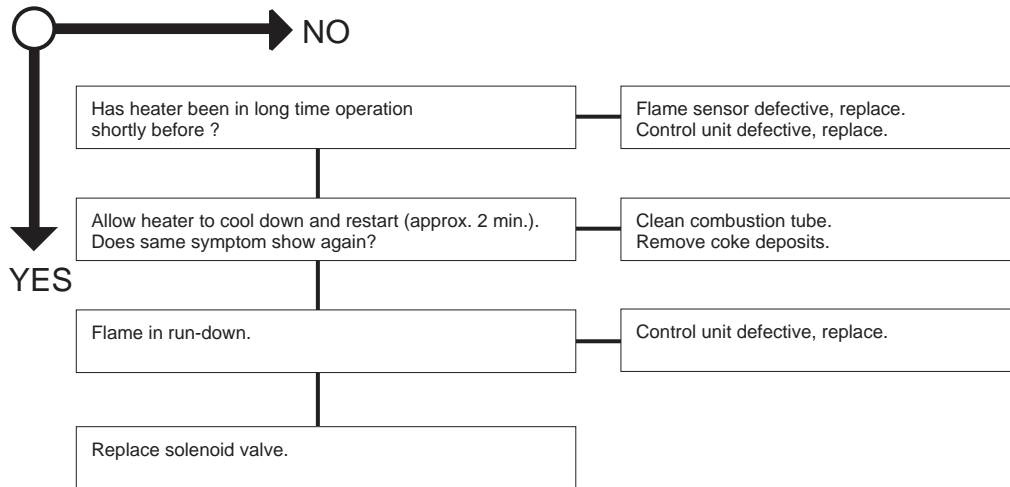
stops any further attempts to start. This error lockout is superior to the normal error lockout condition. The error lockout reset is achieved by switching the heater on and disconnection of the heater power supply during run-down.



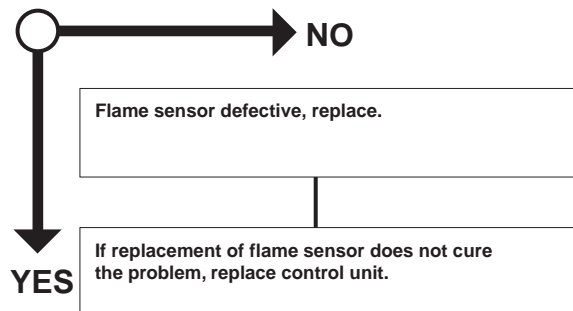
## 5.3.2.3 Fault Symptom "Low Voltage"



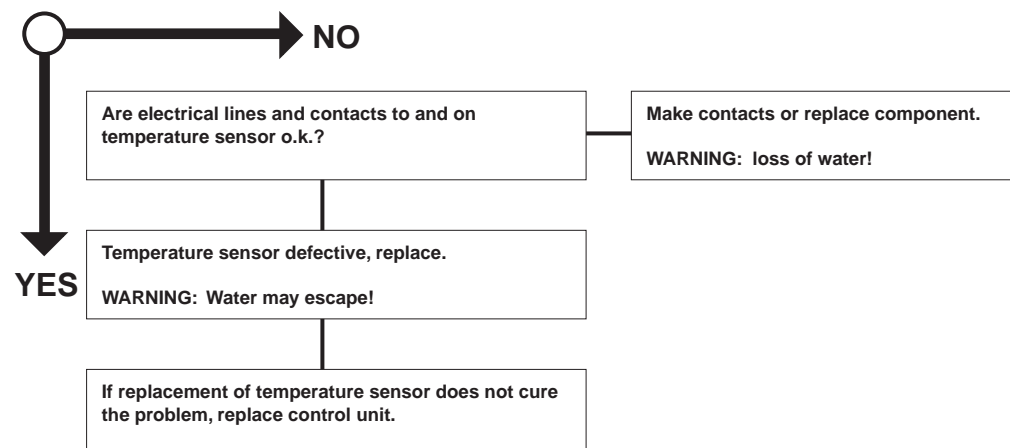
### 5.3.2.4 Fault Symptom "Foreign Light Detection during Run-up or Run-down"



### 5.3.2.5 Fault Symptom "Flame Sensor Defective"

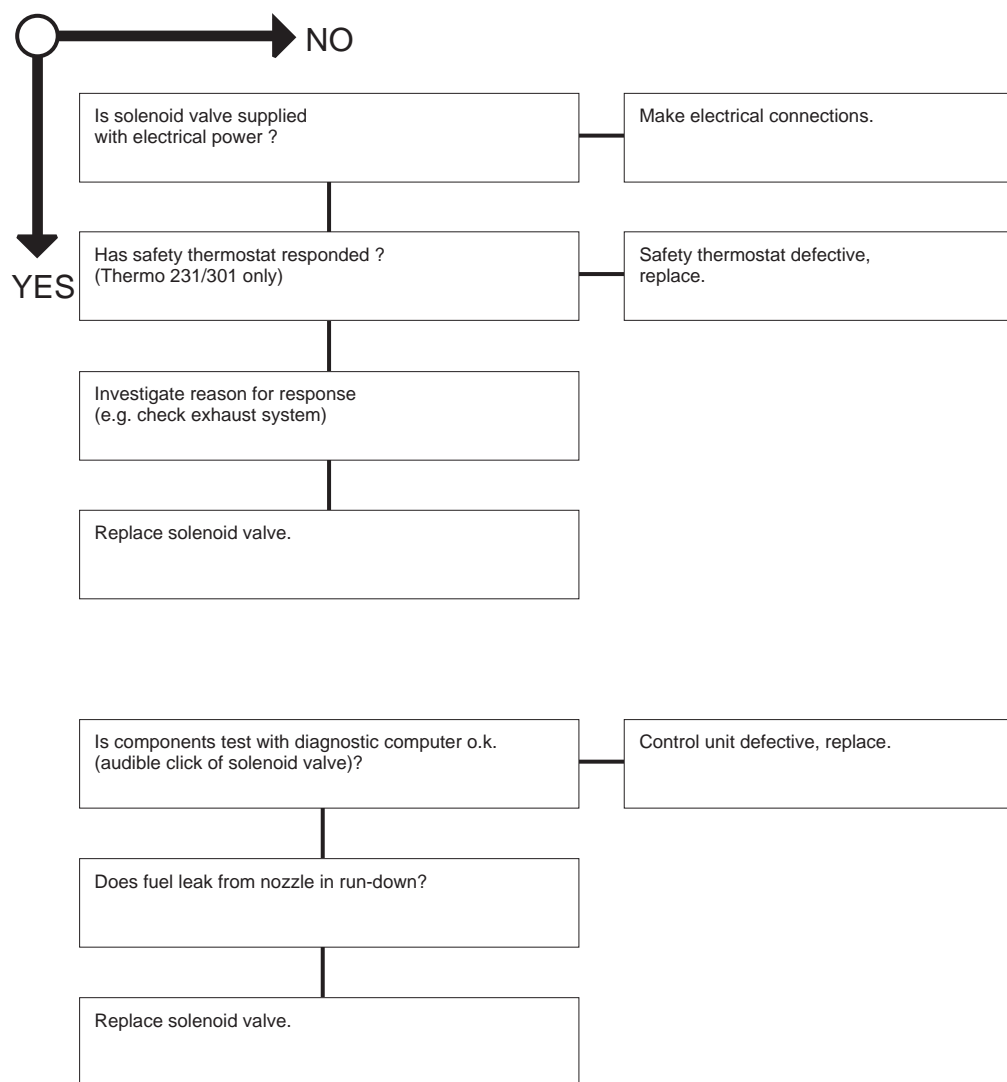


### 5.3.2.6 Fault Symptom "Temperature Sensor Defective"

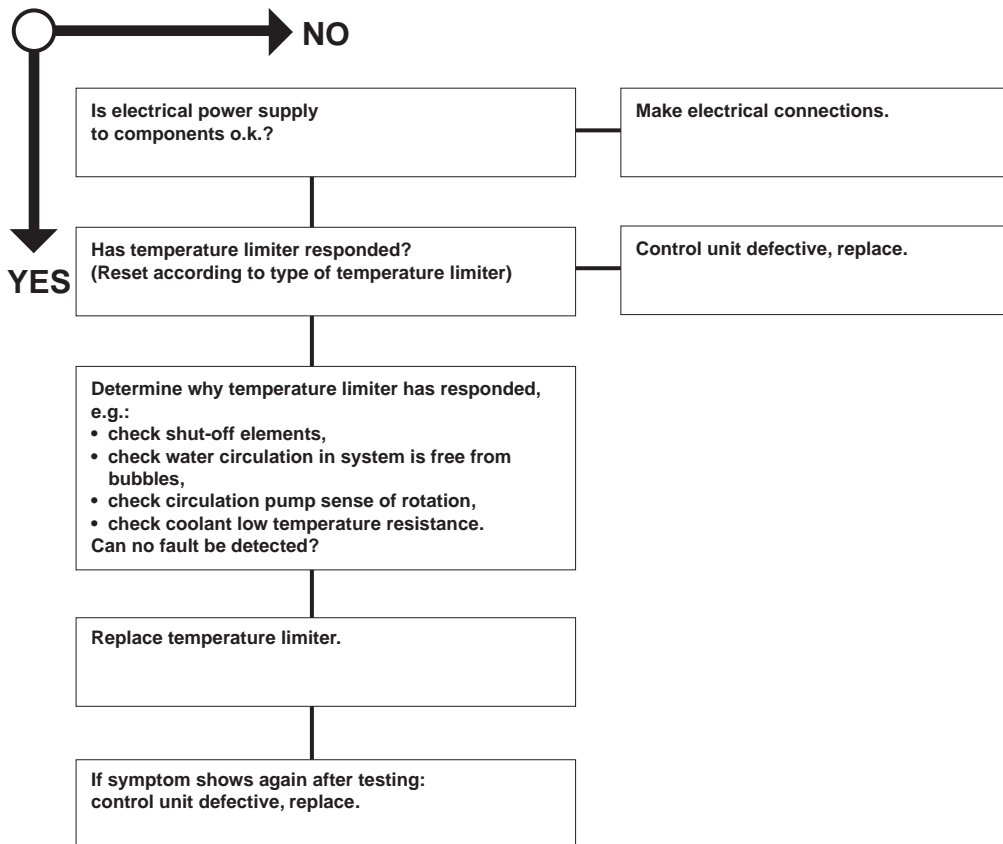




## 5.3.2.7 Fault Symptom "Solenoid Valve Defective"



## 5.3.2.8 Fault Symptom "Temperature Limiter Defective"



## 6 Functional Checkouts

### 6.1 General

This section describes the tests and adjustments on the heater in installed and removed condition to prove its serviceability.

#### WARNING

The heater must not be operated in closed areas like garages or workshops with no exhaust ventilation facilities.

To prevent fires do not switch heater on with burner swung open.

### 6.2 Adjustments

#### 6.2.1 Adjustment of CO<sub>2</sub> Contents

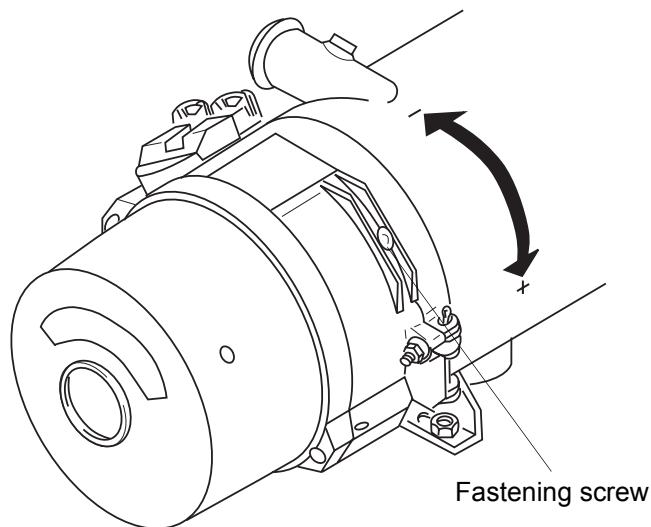
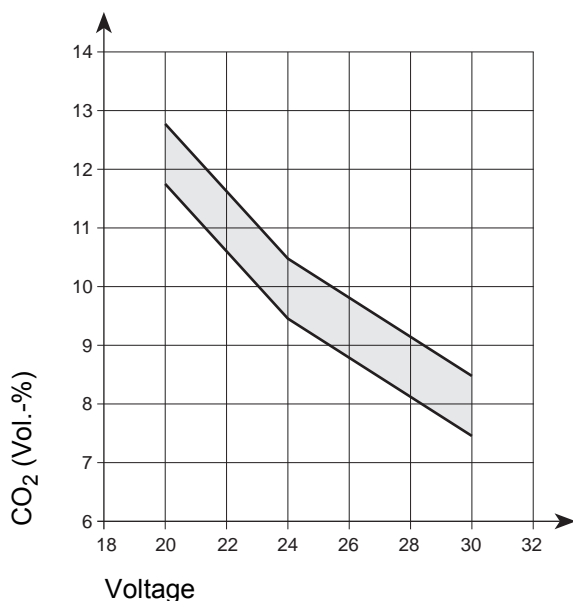
It is allowed to change the manufacturer's setting for combustion air quantity by rotation of the setting ring.

Measurement of the CO<sub>2</sub> value of the exhaust gas must be performed followed by an adjustment of the combustion air quantity as required in case of:

- repairs on the burner
- irregularities in combustion
- functional checkouts
- nozzle replacement

#### Setting procedure

- measure control unit power supply voltage
- operate heater for approximately 5 min.
- measure CO<sub>2</sub> contents and smoke spot number and compare with relevant diagram



- loosen fastening screw (refer to Fig.) and reposition setting ring with fastening screw until rated value is obtained.
- tighten fastening screw with 1.0 +0.5 Nm and apply screw seal varnish.

#### NOTE

CO<sub>2</sub> setting depends on fuel (viscosity) and on geodetic altitude (0.1 % per 100 m).

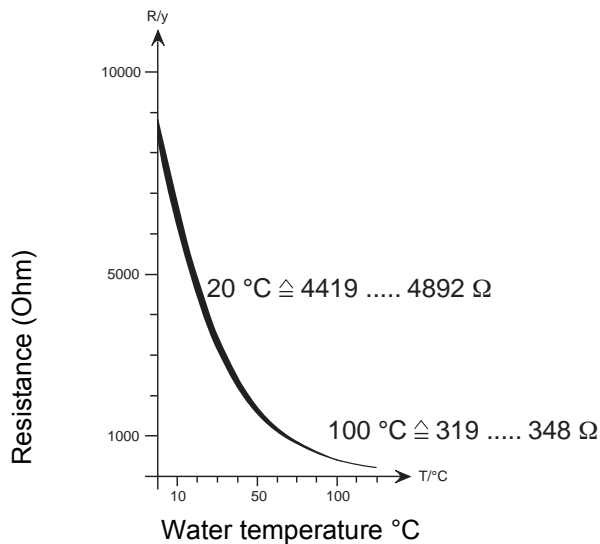
If proper setting cannot be obtained or when exceeding smoke spot number, proceed as follows:

- check burner head air side for damage and replace if required
- check fuel pump pressure and replace pump if required
- check fuel filter and strainer in fuel pump for contamination and replace if required
- adjust pressure
- replace fuel nozzle
- measure burner motor speed

### 6.3 Components Testing

#### 6.3.1 Temperature Sensor Resistance Check

When checking the temperature sensor with a digital multimeter the values of the following diagram must be obtained. Resistance checking is preferably performed at ambient temperatures between 20° C and approximately 100° C (immerse sensor in water).



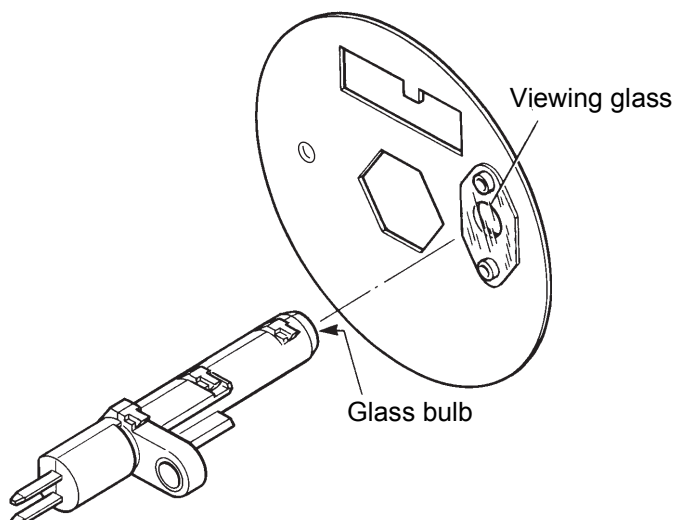
#### 6.3.2 Flame Sensor Resistance Check

##### NOTE

The glass bulb of the flame sensor and the viewing glass of the window (refer to Fig.) are to be cleaned if contaminated. In case of damage or not obtaining the rated values replace flame sensor.

##### Check

- cover flame sensor glass bulb
- check resistance (rated value: < 20 kOhm)
- uncover flame sensor glass bulb and expose to light of strong lamp.
- check resistance (rated value: < 400 Ohm)



### 6.3.3 Igniter Electrodes Check

##### NOTE

The insulator of the igniter electrodes must show no damage. Igniter electrodes not working properly must be replaced.

##### Check

- inspect insulators of igniter electrodes for damage

### 6.3.4 Igniter Box Check

#### NOTE

The igniter box may also be tested using the PC heater diagnosis (component test).

#### WARNING

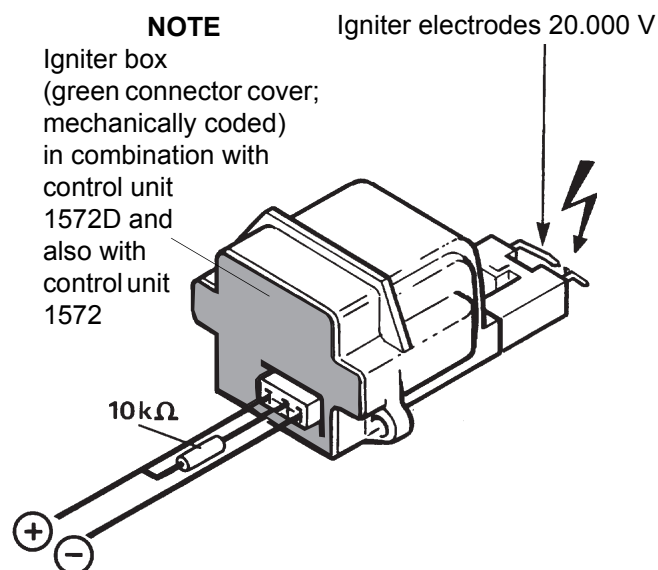
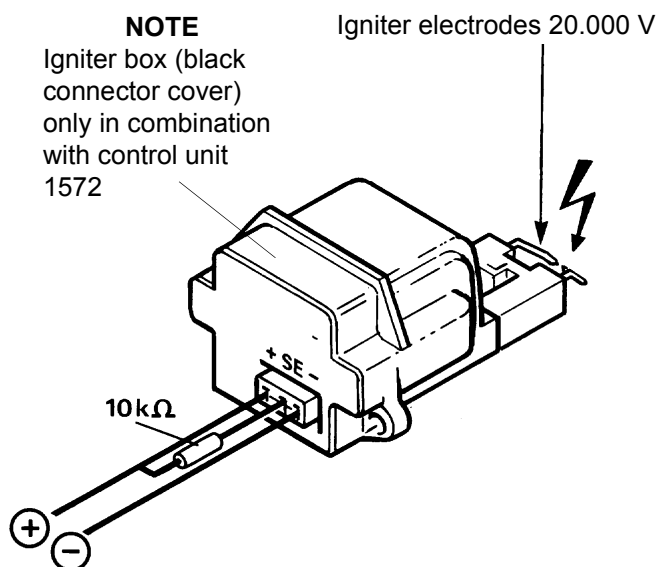
High voltage; 20.000 volts arcing across the igniter electrodes.

#### CAUTION

Do not apply voltage to igniter box without electrodes.

#### Check

- apply 24 V as shown on figure
- normal condition: spark between electrodes.



### 6.3.5 Fuel Pump Check

#### 6.3.5.1 Fuel Pump Check on Heaters with Control Unit 1572

A test gauge is required for performing the test. Such a gauge (with a range from 0 to 15 bar) can be procured from your authorized Spheros dealer.

The fuel pump and the fuel hoses must be replaced every 5 years.

#### CAUTION

The electronic ignition coil must be removed for safety reasons.

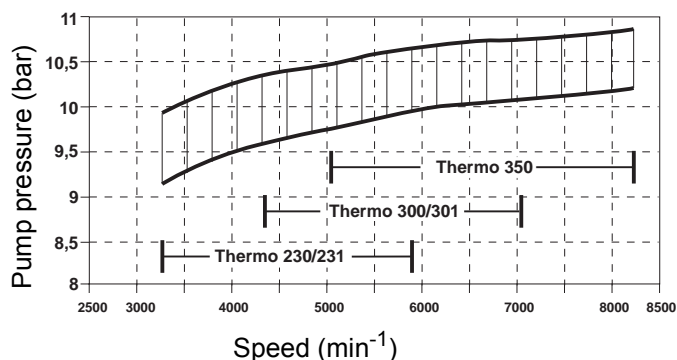
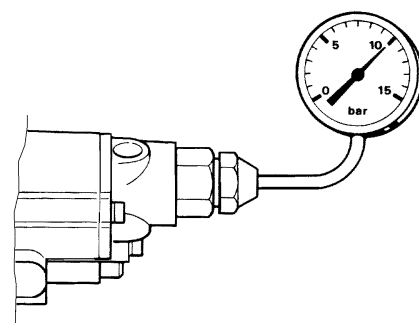
#### Check

- remove igniter box (refer to 9.2.7.1).
- remove nozzle.
- screw on tester.
- cover flame sensor.
- switch on heater.
- after approximately 13 sec. pump pressure is indicated (refer to diagram).
- switch off heater.
- unscrew tester.

#### CAUTION

Do not damage nozzle bore.

- screw in nozzle and torque with 20 Nm.
- install igniter box (refer to 9.2.7.2).



Pump pressure in relation to speed

## 6.3.5.2 Fuel Pump Check on Heaters with Control Unit 1572D

**NOTE**

On heaters with control unit 1572D the fuel pump may only be checked by means of the PC heater diagnosis. The fuel pump and the fuel hoses must be replaced every 5 years.

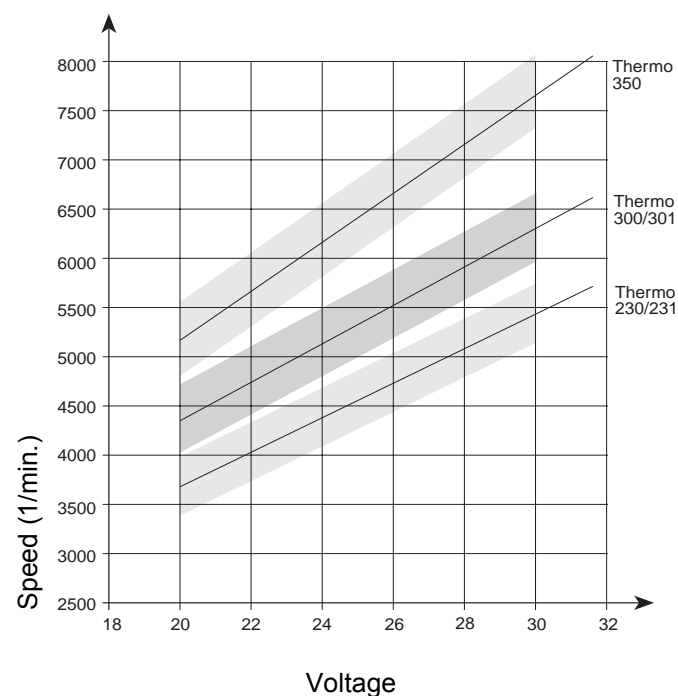
## 6.3.6 Fan Motor Check

**NOTE**

The fan motor check is performed with the burner installed. If normal conditions are not obtained the fan motor must be replaced.

**Check**

- check fan motor bearing condition(binding)
  - measure heater power supply voltage
  - switch on heater
  - measure speed and compare with the diagram below
- |                |           |         |
|----------------|-----------|---------|
| Thermo 230/231 | 4400 ±350 | 24 Volt |
| Thermo 300/301 | 5200 ±420 | 24 Volt |
| Thermo 230     | 6200 ±500 | 24 Volt |



## 6.3.7 Solenoid Valve Check

**NOTE**

A solenoid valve leaking valve seat shows by rather long smoke emissions during run-down. In this case fuel keeps dripping through the fuel nozzle. Short smoke emissions are normal caused by clearing the area between solenoid valve and nozzle bore.

**Check****CAUTION**

Disconnect solenoid valve connector from control unit to avoid damage to the control unit.

- Check electrics for the following values:
  - break voltage 17.0 Volts
  - operating voltage 19.2 ... 28.8 Volts
  - power consumption at nominal voltage and 20° C 10 Watts
  - nominal current 0.42 Amps

**NOTE**

With all variants of the control unit the solenoid valve may also be checked by means of the PC heater diagnosis (component test).

## 6.3.8 Nozzle Block Preheater Check

**NOTE**

At a temperature of < 0° C the heater cartridge in the nozzle block is activated. The heating period depends on the heat reflected within the combustion chamber. Preheating is deactivated when the thermostat ambient temperature is +8° C. Power consumption is 130 ±13 Watts at 24 Volt.

**Check**

- swing burner head open or remove
- disconnect electrical connector
- connect ohmmeter to connector
- using cooling spray cool down thermostat or bridge
- resistance (max. 4.5 Ω).

## **7 Circuit Diagrams**

### **7.1 General**

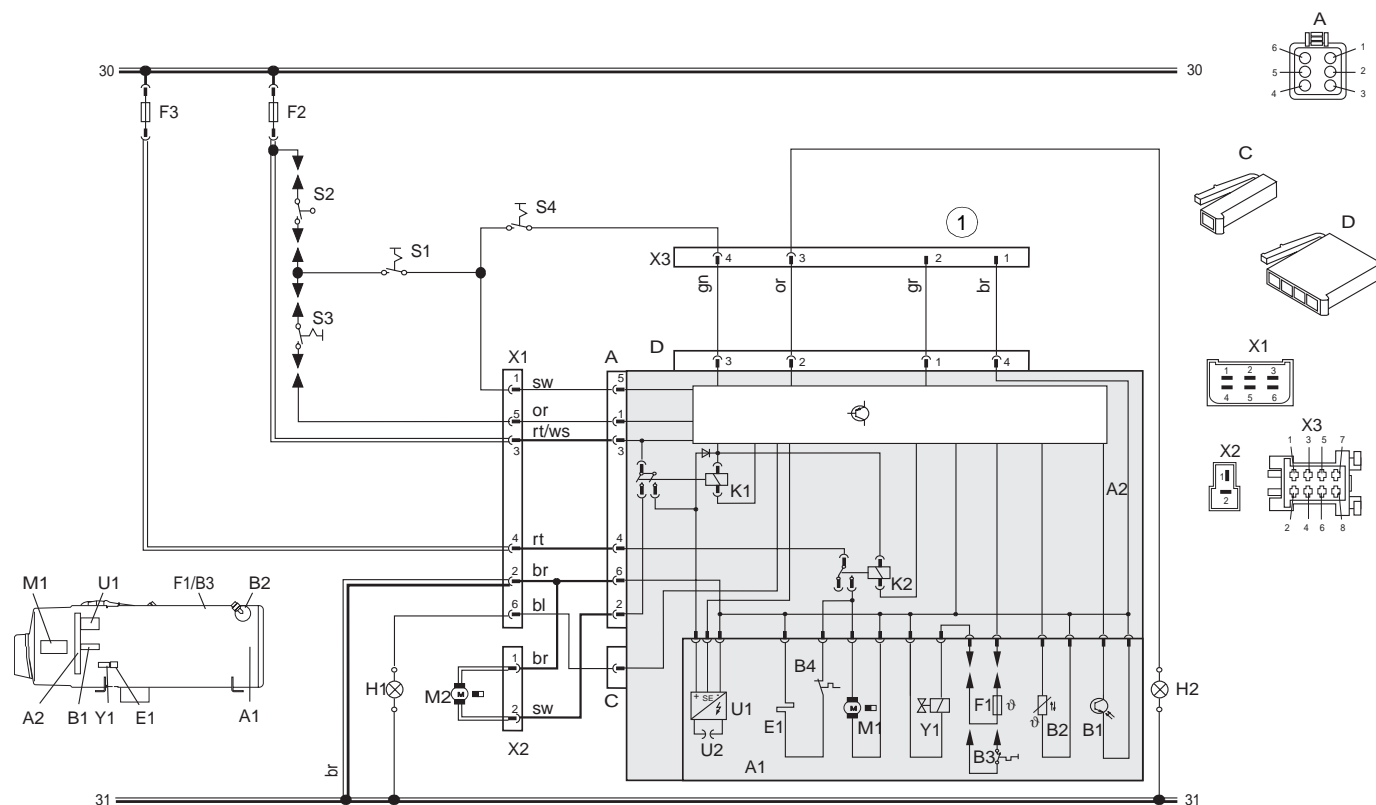
The circuit diagrams (Fig. 701 and 702) show possible heater circuits for *Thermo 230, 300* and *350* with control unit 1572 and with

- switch
- timer 1529 (triple timer)

The circuit diagrams (Fig. 703 and 704) show possible heater circuits for *Thermo 230, 231, 300, 301* and *350* with control unit 1572D and with

- switch
- standard timer 1531

The circuit diagrams (Fig. 705 through 710) show possible variants of heater circuits for *Thermo 230, 231, 300, 301* and *350* with control unit 1572D.



① Diagnostic connector

Wire gauges

	< 7.5 m	7.5 - 15 m
	0.75 mm <sup>2</sup>	1.5 mm <sup>2</sup>
	1.0 mm <sup>2</sup>	1.5 mm <sup>2</sup>
	1.5 mm <sup>2</sup>	2.5 mm <sup>2</sup>
	2.5 mm <sup>2</sup>	4.0 mm <sup>2</sup>
	4.0 mm <sup>2</sup>	6.0 mm <sup>2</sup>

Wire colors

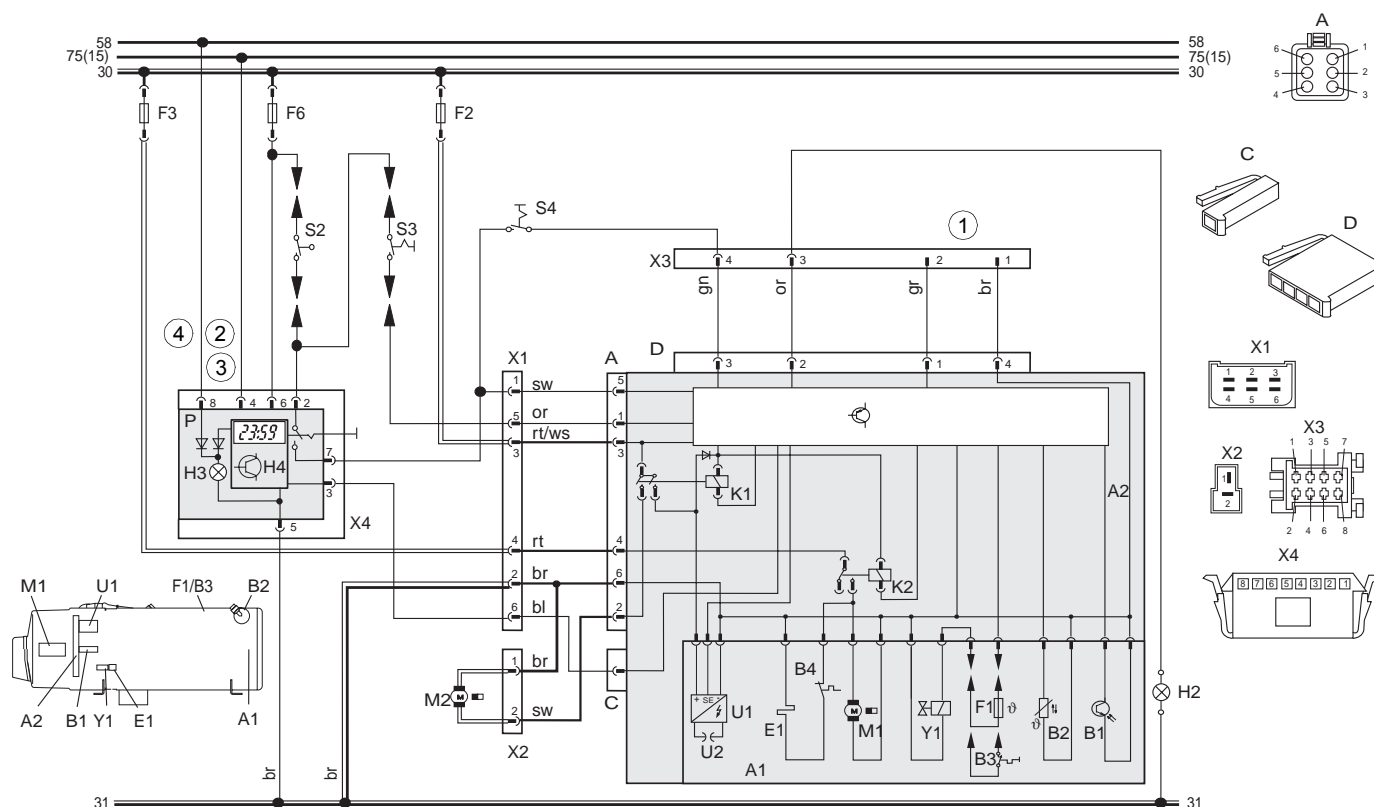
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572
B1	Flame sensor	
B2	Temperature sensor	
B3	Temperature limiter	
B4	Thermostat	open at T > 8 °C
E1	Heating cartridge	for nozzle preheating
F2	Fuse 25A	flat fuse SAE J 1284
F3	Fuse 25A	flat fuse SAE J 1284
H1	Light	operation indicator light
K1	Relay (in item A2)	for circulation pump
K2	Relay (in item A2)	for combustion air fan / heating cartridge
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S2	Continuity switch	on water cock

Item	Nomenclature	Remark
S3	Switch, external trigger circulation pump	
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
Y1	Solenoid valve	

Fig. 701 Automatic Control Circuit with Control Unit 1572 and Switch





- ① Diagnostic connector
- ② to vehicle terminal +75 if available, otherwise terminal 15
- ③ Timer P:  
with plus to connection 4 = continuous operation during immediate heating  
without plus to connection 4 = heating period 1 hour
- ④ vehicle lighting terminal 58

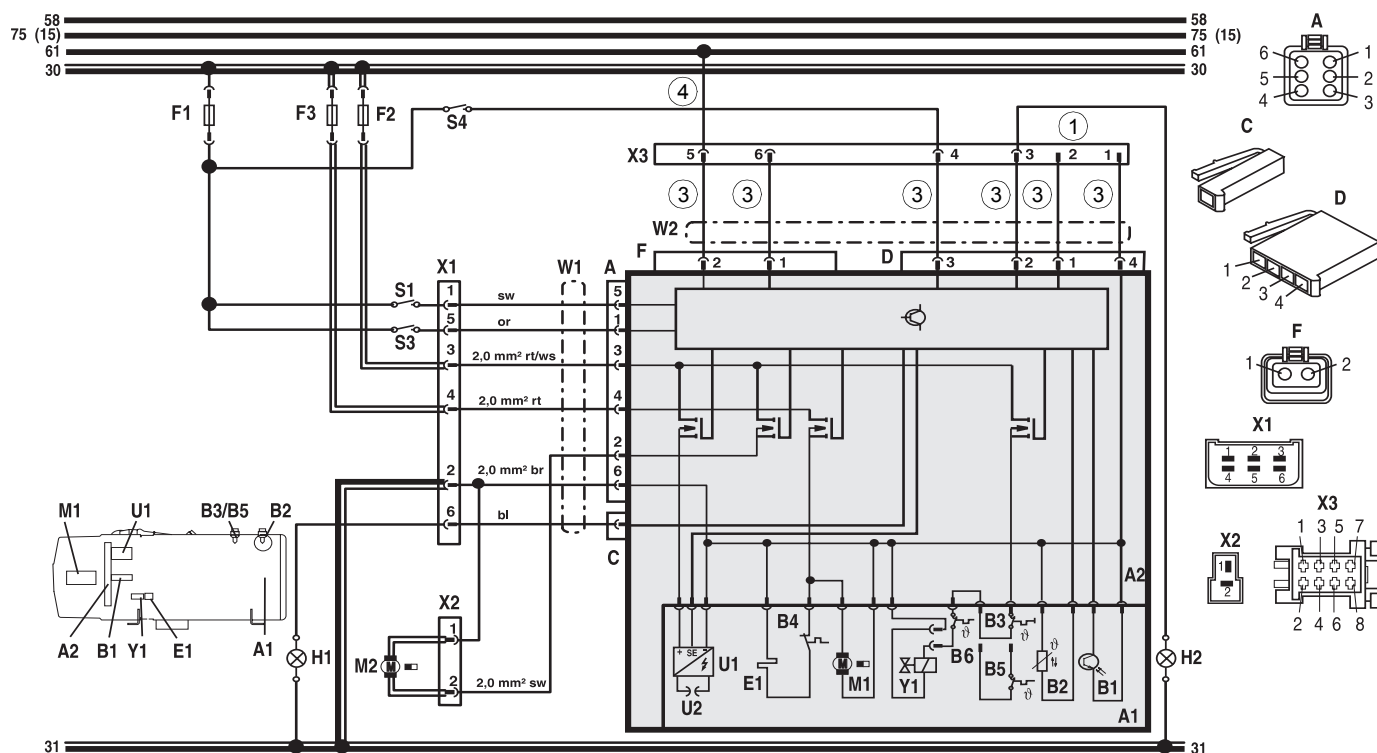
Wire gauges		
	< 7.5 m	7.5 - 15 m
	0.75 mm <sup>2</sup>	1.5 mm <sup>2</sup>
	1.0 mm <sup>2</sup>	1.5 mm <sup>2</sup>
	1.5 mm <sup>2</sup>	2.5 mm <sup>2</sup>
	2.5 mm <sup>2</sup>	4.0 mm <sup>2</sup>
	4.0 mm <sup>2</sup>	6.0 mm <sup>2</sup>

Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572
B1	Flame sensor	
B2	Temperature sensor	
B3	Temperature limiter	
B4	Thermostat	opens at T > 8 °C
E1	Heating cartridge	for nozzle preheating
F2	Fuse 25A	flat fuse SAE J 1284
F3	Fuse 25A	flat fuse SAE J 1284
F6	Fuse 5A	flat fuse SAE J 1284
H3	Light in item P	symbol lighting
H4	Symbol for "Heating" in Display	symbol lighting (in item P)
K1	Relay (in item A2)	for circulation pump
K2	Relay (in item A2)	for combustion air fan / heating cartridge
M1	Motor	combustion air fan
M2	Motor	circulation pump
P	Triple timing clock (1529)	for timed operation

Item	Nomenclature	Remark
S2	Continuity switch	on water cock
S3	Switch, external trigger circulation pump	
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
X4	Plug connections, 8-pole	
Y1	Solenoid valve	

Fig. 702 Automatic Control Circuit with Control Unit 1572 and Timer (Triple Timer)



① Diagnostic connector

③ Pin assignment:

Pin assignment	4wire lead	7wire lead
D1	0,75 gr	0,75 rt
D2	0,75 or	0,75 or
D3	0,75 gn	0,75 bl
D4	0,75 br	2,0 br
F1	nicht belegt	2,0 sw
F2	nicht belegt	2,0 rt/ws

④ with connection to terminal 61 auxiliary

Wire gauges

	< 7.5 m	7.5 - 15 m
	0.75 mm²	1.5 mm²
	1.0 mm²	1.5 mm²
	1.5 mm²	2.5 mm²
	2.5 mm²	4.0 mm²
	4.0 mm²	6.0 mm²

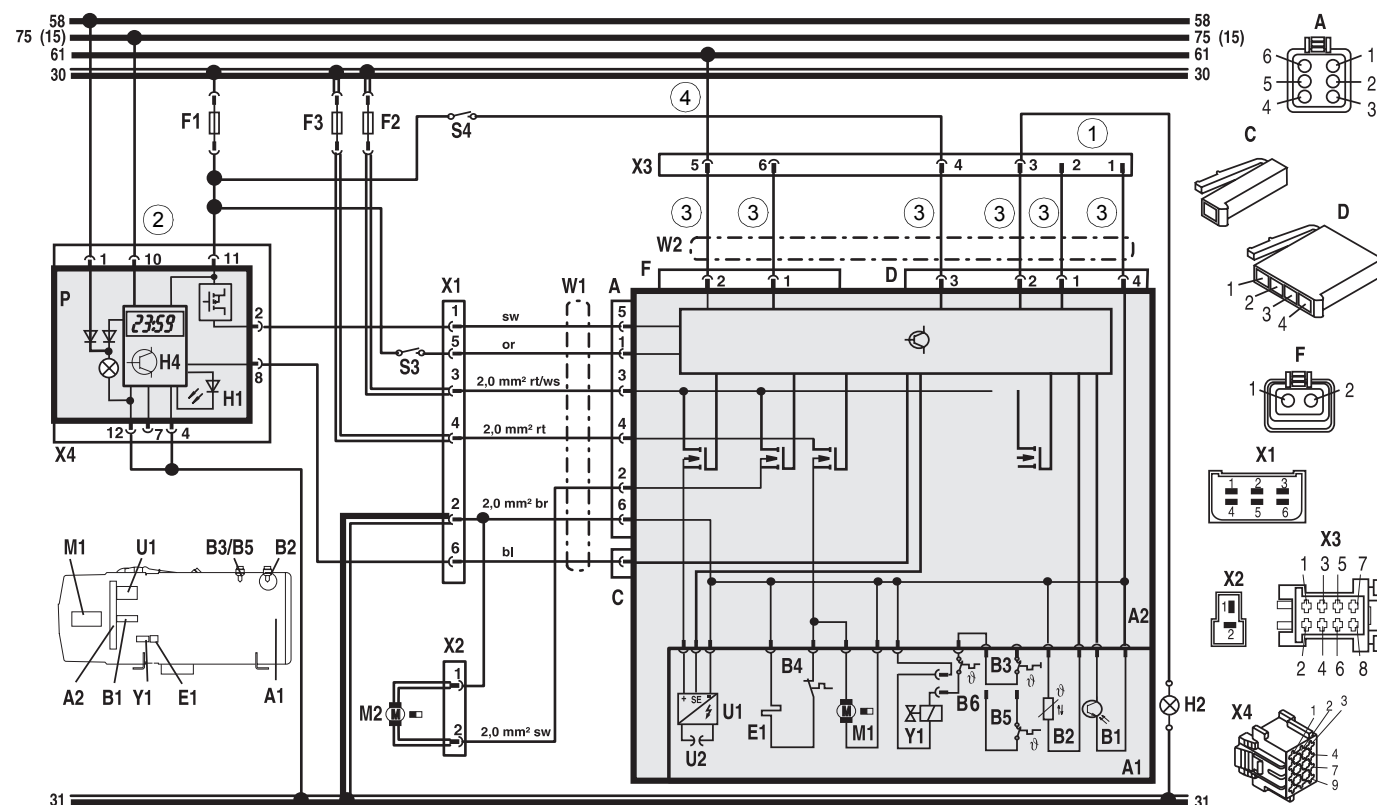
Wire colors

bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
B5	Thermostat	alternative to B3
B6	Thermostat	for vertical installation (MV Y1)
E1	Heating cartridge	for nozzle preheating
F1	Fuse 5 A	flat fuse DIN 72581 part 3
F2	Fuse 25 A	flat fuse DIN 72581 part 3
F3	Fuse 25 A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S3	Switch	external trigger circulation pump

Item	Nomenclature	Remark
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness (1)	
W2	Wiring harness (2)	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
F	Plug connections, 2-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
Y1	Solenoid valve	

Fig. 703 Automatic Control Circuit with Control Unit 1572D and Switch



- ① Diagnostic connector
- ② Timer P:  
with plus to connection 10 = continuous operating during immediate heating  
terminal 10 not connected = duration of heating programmable (10 min to 120 min);
- ③ Pin assignment:
- | Pin assignment | 4wire lead | 7wire lead |
|----------------|------------|------------|
| D1             | 0.75 gr    | 0.75 rt    |
| D2             | 0.75 or    | 0.75 or    |
| D3             | 0.75 gn    | 0.75 bl    |
| D4             | 0.75 br    | 2.0 br     |
| F1             | not used   | 2.0 sw     |
| F2             | not used   | 2.0 rt/ws  |
- ④ with connection to terminal 61 auxiliary

Wire gauges	
	< 7.5 m
	0.75 mm²
	1.0 mm²
	1.5 mm²
	2.5 mm²
	4.0 mm²
	7.5 - 15 m
	1.5 mm²
	2.5 mm²
	4.0 mm²
	6.0 mm²

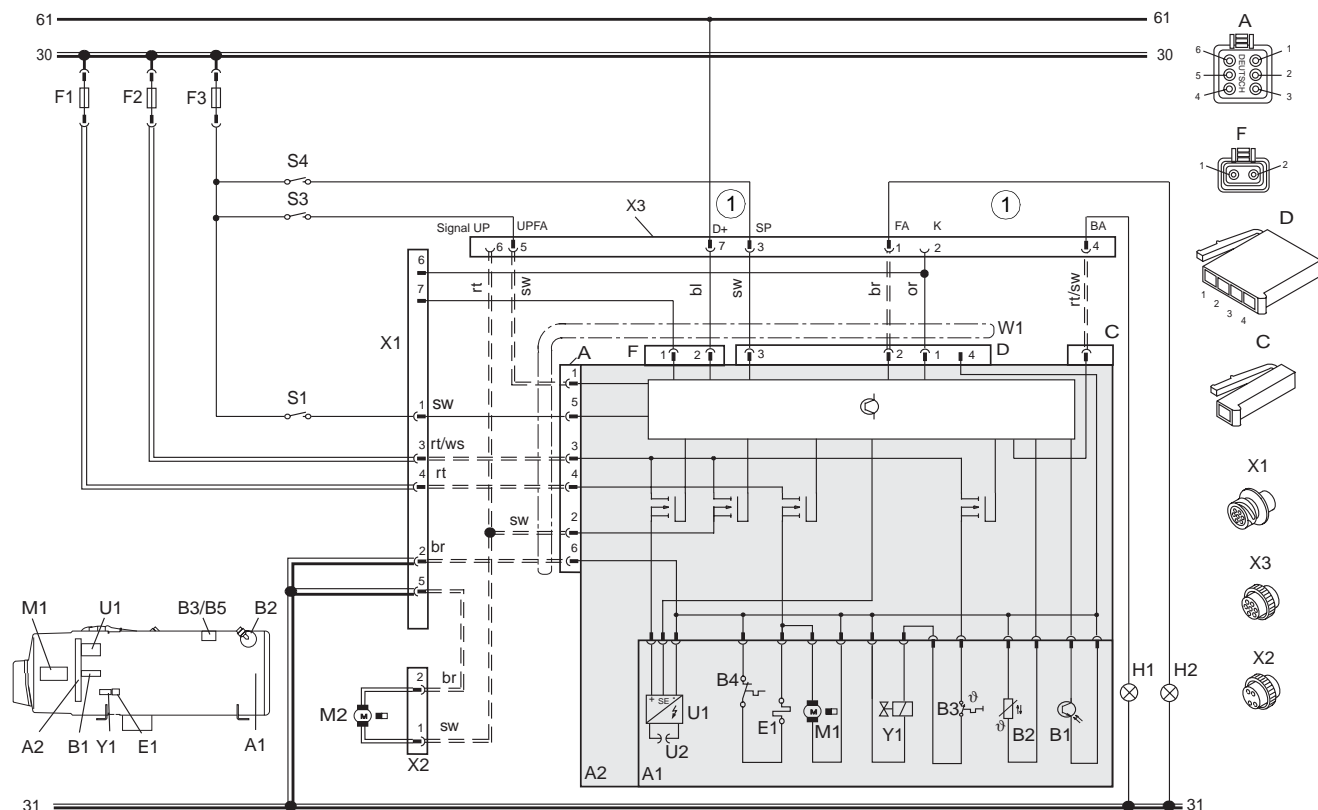
## Wire colors

bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white







Item	Nomenclature	Remark
A1	Heater	
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
B5	Thermostat	alternative to B3
B6	Thermostat	for vertical installation (MV Y1)
E1	Heating cartridge	for nozzle preheating
F1	Fuse 5 A	flat fuse DIN 72581 part 3
F2	Fuse 25 A	flat fuse DIN 72581 part 3
F3	Fuse 25 A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
H4	Symbol for "Heating" in Display	symbol lighting (in item P)
M1	Motor	combustion air fan
M2	Motor	circulation pump

Item	Nomenclature	Remark
P	Standard timer (1531)	for timed operation
S3	Switch	external trigger circulation pump
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness (1)	
W2	Wiring harness (2)	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
F	Plug connections, 2-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
X4	Plug connections, 12-pole	
Y1	Solenoid valve	

Fig. 704 Automatic Control Circuit with Control Unit 1572D and Standard Timer



① Diagnostic connector

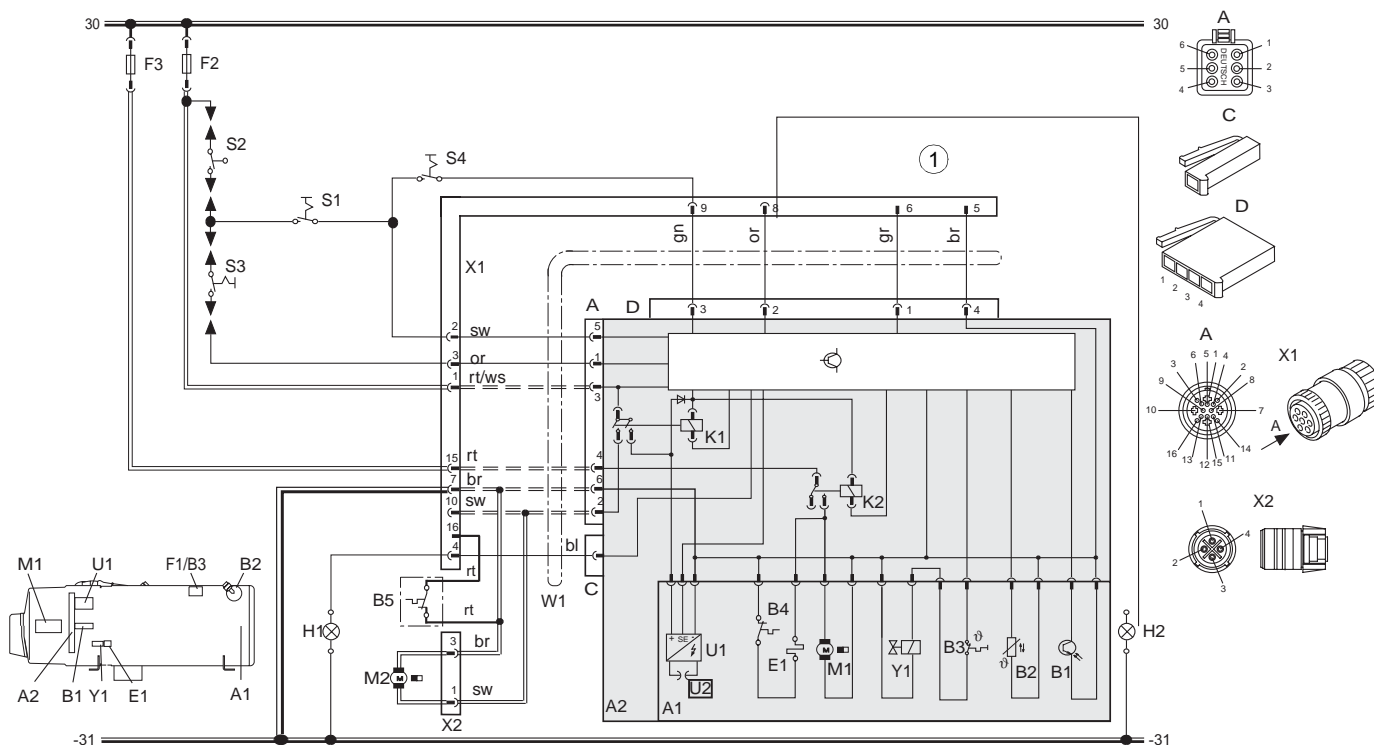
Wire gauges		
	< 7,5 m	7,5 - 15 m
	0,75 mm <sup>2</sup>	1,5 mm <sup>2</sup>
	1,0 mm <sup>2</sup>	1,5 mm <sup>2</sup>
	1,5 mm <sup>2</sup>	2,5 mm <sup>2</sup>
	2,0 mm <sup>2</sup>	? mm <sup>2</sup>
	2,5 mm <sup>2</sup>	4,0 mm <sup>2</sup>
	4,0 mm <sup>2</sup>	6,0 mm <sup>2</sup>

Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
E1	Heating cartridge	for nozzle preheating
F1	Fuse 25 A	flat fuse DIN 72581 part 3
F2	Fuse 25 A	flat fuse DIN 72581 part 3
F3	Fuse 5 A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S3	Switch	external trigger circulation pump
S4	Switch	power save operation
U1	Igniter box	

[illegible]






Fig. 705 System Circuit Daimler Chrysler Citaro, Ident.-Nr. 67131



① Diagnostic connector

Fuse acc. to SAE J 1284 / DIN 72581			
	DW 230	DW 300	DW 350
<b>F2</b>	25A / 16A	25A / 16A	25A / 16A
<b>F3</b>	25A / 16A	25A / 16A	25A / 16A

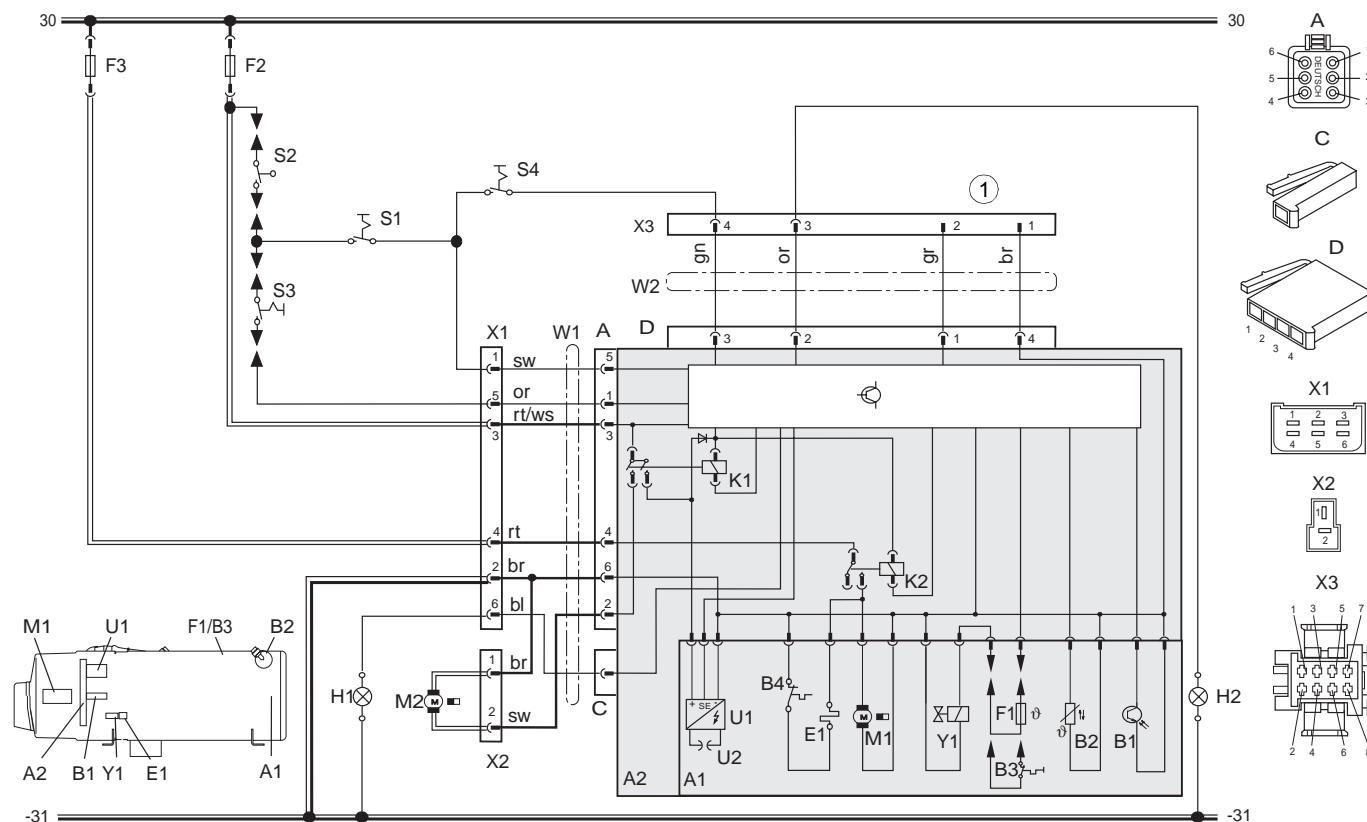
Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Wire gauges		
	< 7,5 m	7,5 - 15 m
	0,75 mm <sup>2</sup>	1,5 mm <sup>2</sup>
	1,0 mm <sup>2</sup>	1,5 mm <sup>2</sup>
	1,5 mm <sup>2</sup>	2,5 mm <sup>2</sup>
	2,0 mm <sup>2</sup>	? mm <sup>2</sup>
	2,5 mm <sup>2</sup>	4,0 mm <sup>2</sup>
	4,0 mm <sup>2</sup>	6,0 mm <sup>2</sup>

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	alternative to F1
B4	Thermostat	for nozzle preheating
B5	Fire sensor	Van Hool
E1	Heating cartridge	
F2	Fuse	see table
F3	Fuse	see table
H1	Light	operation indicator light
H2	Light	flame indicator
K1	Relay (in item A2)	for circulation pump motor
K2	Relay (in item A2)	for combustion air fan
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S2	Continuity switch	on water cock

[illegible]

Fig. 706 System Circuit Van Hool, Ident.-Nr. 89401



① Diagnostic connector

Fuse acc. to SAE J 1284 / DIN 72581			
	DW 230	DW 300	DW 350
F2	25A / 16A	25A / 16A	25A / 16A
F3	25A / 16A	25A / 16A	25A / 16A

#### Wire colors

bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

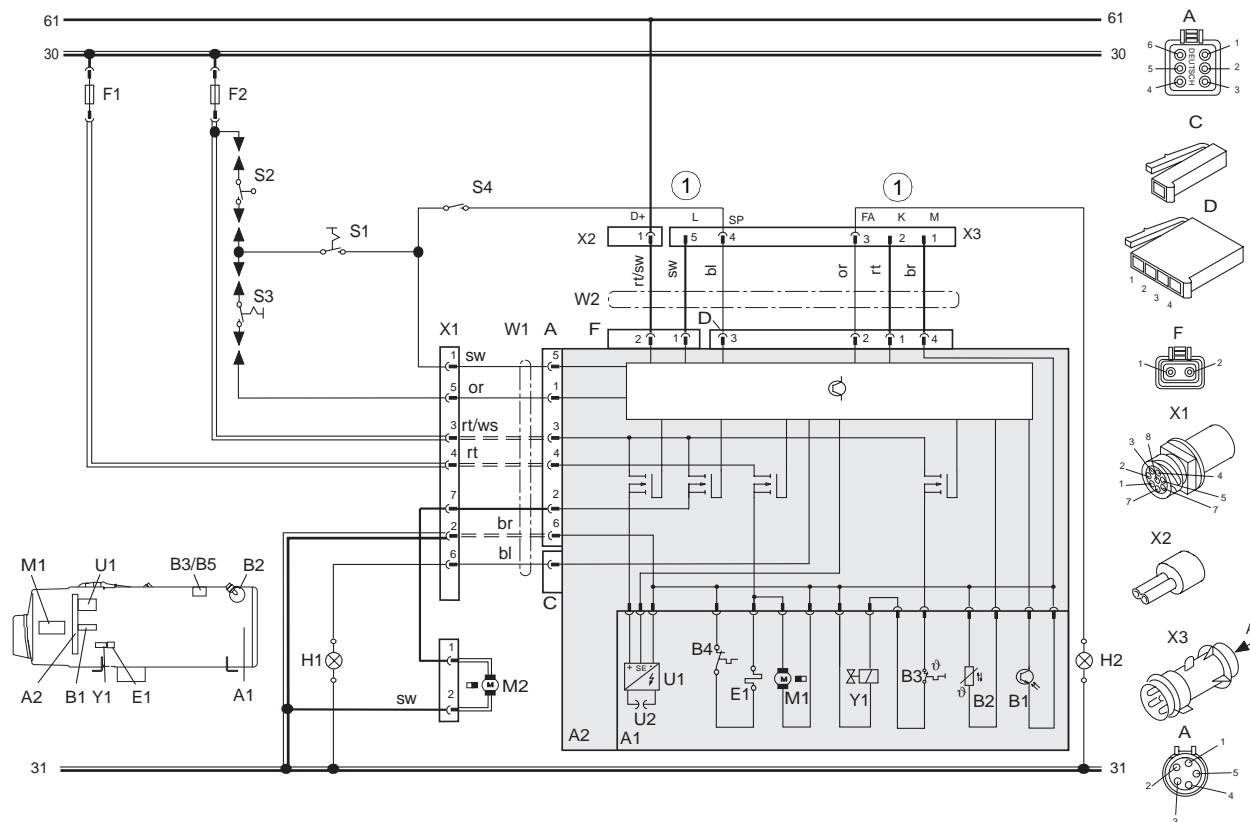
#### Wire gauges

	< 7,5 m	7,5 - 15 m
—	0,75 mm <sup>2</sup>	1,5 mm <sup>2</sup>
==	1,0 mm <sup>2</sup>	1,5 mm <sup>2</sup>
===	1,5 mm <sup>2</sup>	2,5 mm <sup>2</sup>
====	2,0 mm <sup>2</sup>	? mm <sup>2</sup>
=====	2,5 mm <sup>2</sup>	4,0 mm <sup>2</sup>
=====	4,0 mm <sup>2</sup>	6,0 mm <sup>2</sup>






Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	alternative to F1
B4	Thermostat	for nozzle preheating
E1	Heating cartridge	for nozzle preheating
F2	Fuse	see table
F3	Fuse	see table
H1	Light	operation indicator light
H2	Light	flame indicator
K1	Relay	for circulation pump motor
K2	Relay	for combustion air fan
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S2	Continuity switch	on water cock

Item	Nomenclature	Remark
S3	Switch, external trigger circulation pump	required, if S2 not installed
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness (1)	
W2	Wiring harness (2)	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
Y1	Solenoid valve	

Fig. 707 System Circuit O405 / O407 / O408, Ident.-Nr. 91292



1 Diagnostic connector

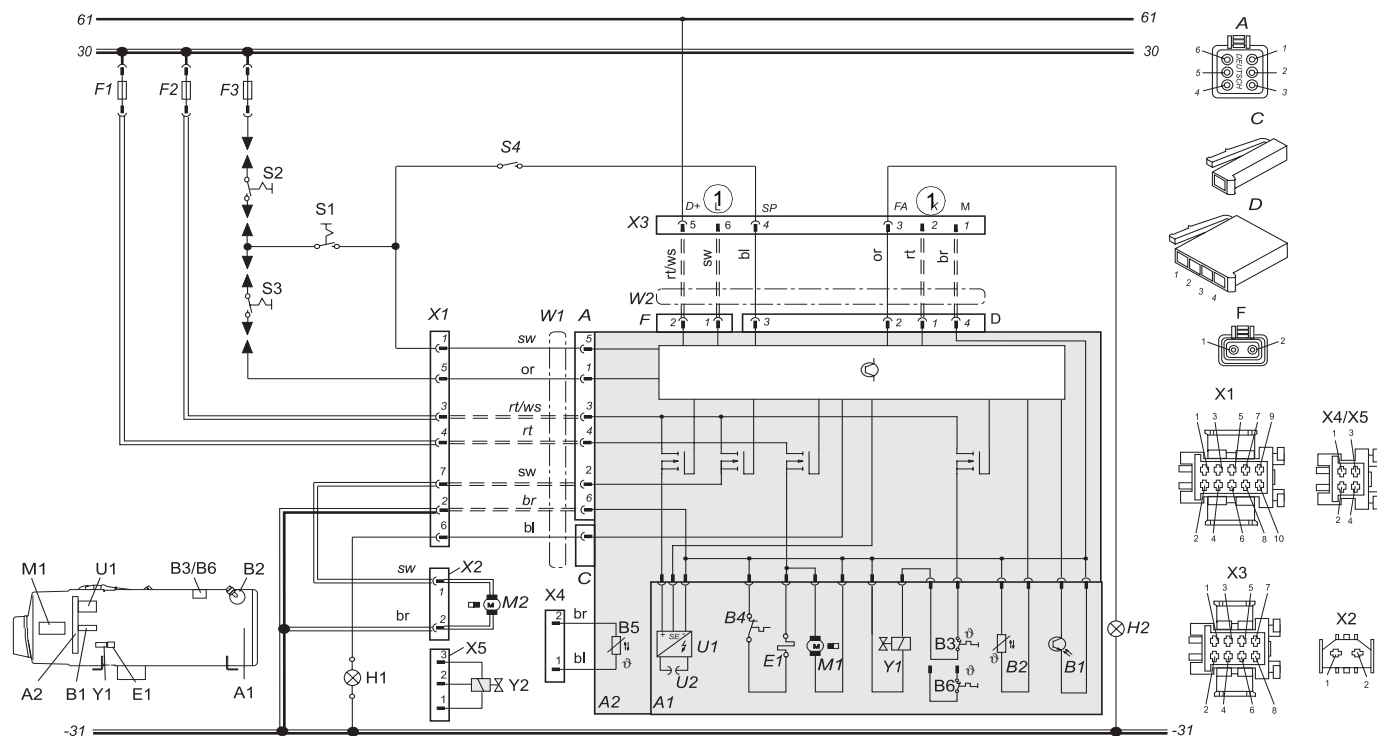
Wire gauges		
	< 7,5 m	7,5 - 15 m
	0,75 mm <sup>2</sup>	1,5 mm <sup>2</sup>
	1,0 mm <sup>2</sup>	1,5 mm <sup>2</sup>
	1,5 mm <sup>2</sup>	2,5 mm <sup>2</sup>
	2,0 mm <sup>2</sup>	? mm <sup>2</sup>
	2,5 mm <sup>2</sup>	4,0 mm <sup>2</sup>
	4,0 mm <sup>2</sup>	6,0 mm <sup>2</sup>

Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
E1	Heating cartridge	for nozzle preheating
F2	Fuse 25 A	flat fuse DIN 72581 part 3
F3	Fuse 25 A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S2	Continuity switch	on water cock
S3	Switch, external trigger circulation pump	required, if S2 not installed
S4	Switch	power save operation

[illegible]

Fig. 708 System Circuit MAN, Ident.-Nr. 89404



1 Diagnostic connector

Wire gauges		
	< 7,5 m	7,5 - 15 m
—	0,75 mm <sup>2</sup>	1,5 mm <sup>2</sup>
==	1,0 mm <sup>2</sup>	1,5 mm <sup>2</sup>
===	1,5 mm <sup>2</sup>	2,5 mm <sup>2</sup>
====	2,0 mm <sup>2</sup>	? mm <sup>2</sup>
=====	2,5 mm <sup>2</sup>	4,0 mm <sup>2</sup>
—————	4,0 mm <sup>2</sup>	6,0 mm <sup>2</sup>

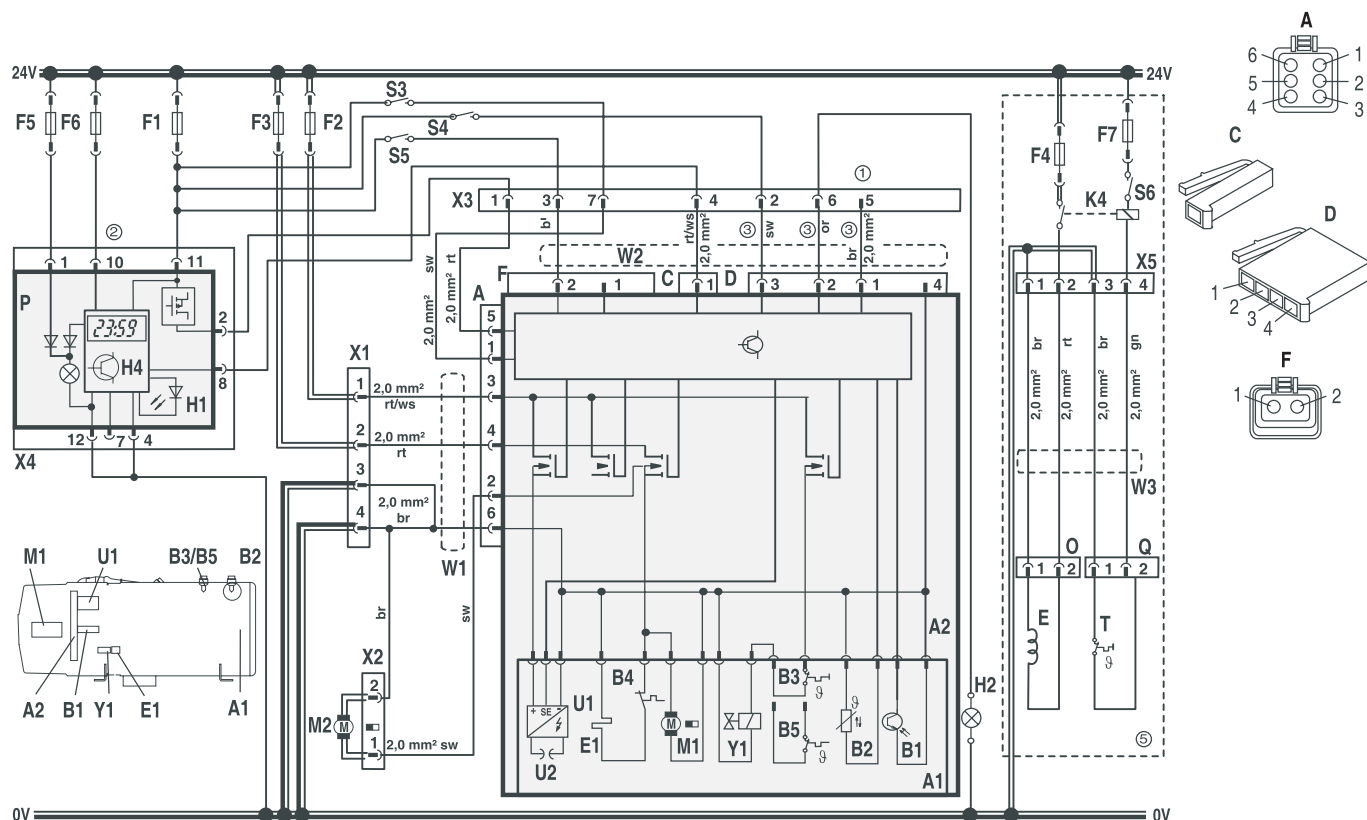
Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
B5	Temperature sensor extern	observe polarity
B6	Thermostat	alternative to B3
E1	Heating cartridge	for nozzle preheating
F1	Fuse 25 A	flat fuse DIN 72581 part 3
F2	Fuse 25 A	flat fuse DIN 72581 part 3
F3	Fuse 5 A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S2	Continuity switch	on water cock

Pos.	Nomenclature	Remark
S3	Switch, external trigger circulation pump	required, if S2 not installed
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness (1)	
W2	Wiring harness (2)	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
F	Plug connections, 2-pole	
X1	Plug connections, 10-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
X4	Plug connections, 4-pole	
X5	Plug connections, 4-pole	
Y1	Solenoid valve	
Y2	Shut-off valve with filter	

Fig. 709 System Circuit SETRA, Ident.-Nr. 90972





- ① Diagnostic connector
- ② Timer P:  
with plus to connection 4 = continuous operating during immediate heating  
without plus to connection 4 = heating period 1 hour
- ③ Pin assignment:
- | Pin assignment | 4wire lead | 7wire lead |
|----------------|------------|------------|
| D1             | 0,75 gr    | 0,75 rt    |
| D2             | 0,75 or    | 0,75 or    |
| D3             | 0,75 gn    | 0,75 bl    |
| D4             | 0,75 br    | 2,0 br     |
| F1             | not used   | 2,0 sw     |
| F2             | not used   | 2,0 rt/ws  |
- ④ Option

Wire gauges	
	< 7,5 m
	7,5 - 15 m
	0,75 mm <sup>2</sup>
	1,0 mm <sup>2</sup>
	1,5 mm <sup>2</sup>
	2,5 mm <sup>2</sup>
	4,0 mm <sup>2</sup>
	6,0 mm <sup>2</sup>

Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	
A2	Control Unit	SG 1572 D
B1	Flame Sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
B5	Thermostat	alternative to B3
B6	Thermostat	for vertical installation (MV Y1)
E	Filter heater	
E1	Heating cartridge	for nozzle preheating
F1	Fuse 5A	flat fuse DIN 72581 part 3
F2	Fuse 25A	flat fuse DIN 72581 part 3
F3	Fuse 25A	flat fuse DIN 72581 part 3
F4	Fuse 25A	flat fuse DIN 72581 part 3
F5	Fuse 5A	flat fuse DIN 72581 part 3
F6	Fuse 5A	flat fuse DIN 72581 part 3
F7	Fuse 5A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
H4	Heating symbol on the display	Power-on indicator (in item P)
K4	Relay	
M1	Motor	combustion air fan
M2	Motor	circulation pump

Item	Nomenclature	Remark
P	Digital timer, standard (1531)	For programmed operation
S1	Switch	on / off
S3	Switch	external trigger circulation pump
S4	Switch	power save operation
S5	Switch	Auxiliary heating mode
S6	Switch	Filter heater on
T	Temperature switch	Filter heater
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness (1)	
W2	Wiring harness (2)	
W3	Wiring harness (3)	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
F	Plug connections, 2-pole	
O	Plug connections, 2-pole	
Q	Plug connections, 2-pole	
X1	Plug connections, 4-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 7-pole	
X4	Plug connections, 12-pole	
X5	Plug connections, 4-pole	
Y1	Solenoid valve	

Fig. 710 Automatic Control Circuit Rail with Control Unit 1572D and Standard Timer and filter heater



## 8. Servicing

### 8.1 General

This section describes the servicing procedures allowed on the heater when installed.

### 8.2 Heater Servicing

As long as the heater is in operation or in run-down the battery main power supply must not be disconnected to prevent the heater from overheating by response of the overheat protection.

When performing long time repairs on the heater its removal is appropriate.

After working on the heating circuit replenish with a coolant mix prepared with water and anti-freeze and bleed circuit afterwards according to manufacturer's instructions.

### 8.3 Vehicle Servicing

#### CAUTION

In the vicinity of the heater a temperature of 110 °C must under no circumstances be exceeded (e.g. during paint work on the vehicle).

### 8.4 Heater Test Run

The heater must not be operated, not even with the timer, in enclosed areas like garages or workshops not equipped with exhaust ventilation facilities.

### 8.5 Maintenance

To ensure functional reliability of the heater the following maintenance must be performed:

- check combustion air inlet and exhaust outlet for contamination and clean as required.
- outside the heating season the heater should be operated with the vehicle engine cold approximately every four weeks for 10 minutes setting the heating system to "warm". This avoids difficulties in the start-up.
- at least once a year, in case of contaminated fuel more often, the fuel filter or filter cartridge as well as the filter screen of the fuel pump must be replaced to avoid malfunctions.
- at least once a year the heat exchanger must be cleaned inside.
- Valid for application 350.190:  
The cleaning of the heat exchanger is to be accom-

plished twice per heating season.

- in case of leakage the fuel pump and the fuel lines must be replaced immediately, otherwise every 5 years.
- the heater should be checked in regular intervals by a Spheros service agent, the latest before the beginning of the heating season (refer to Annex A "Scheduled Maintenance"). When the heater is operated in rail vehicles, maintenance chart / test certificate item no. 90 087 22B is to be used.

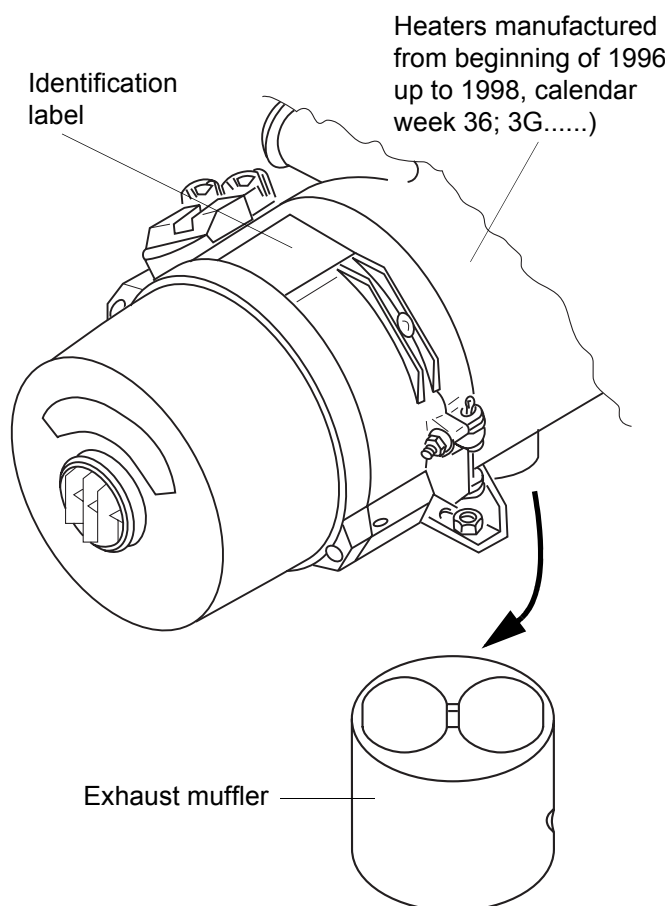
#### 8.5.1 Inspection and Attachment of the Exhaust Muffler (only heaters from year of production 1996 and up to production date 1996, calendar week 36; 3G.....)

#### NOTE

If the exhaust muffler is already secured with a sheet metal screw, the following procedure need not be performed.

#### General

The exhaust muffler of heaters manufactured from the beginning of 1996 up to a manufacturing date of 1998 (calendar week 36; 3G.....) (for year or date of production refer to identification label) the exhaust muffler may get loose or lost under certain circumstances. Therefore an inspection for proper attachment of the muffler should be performed.

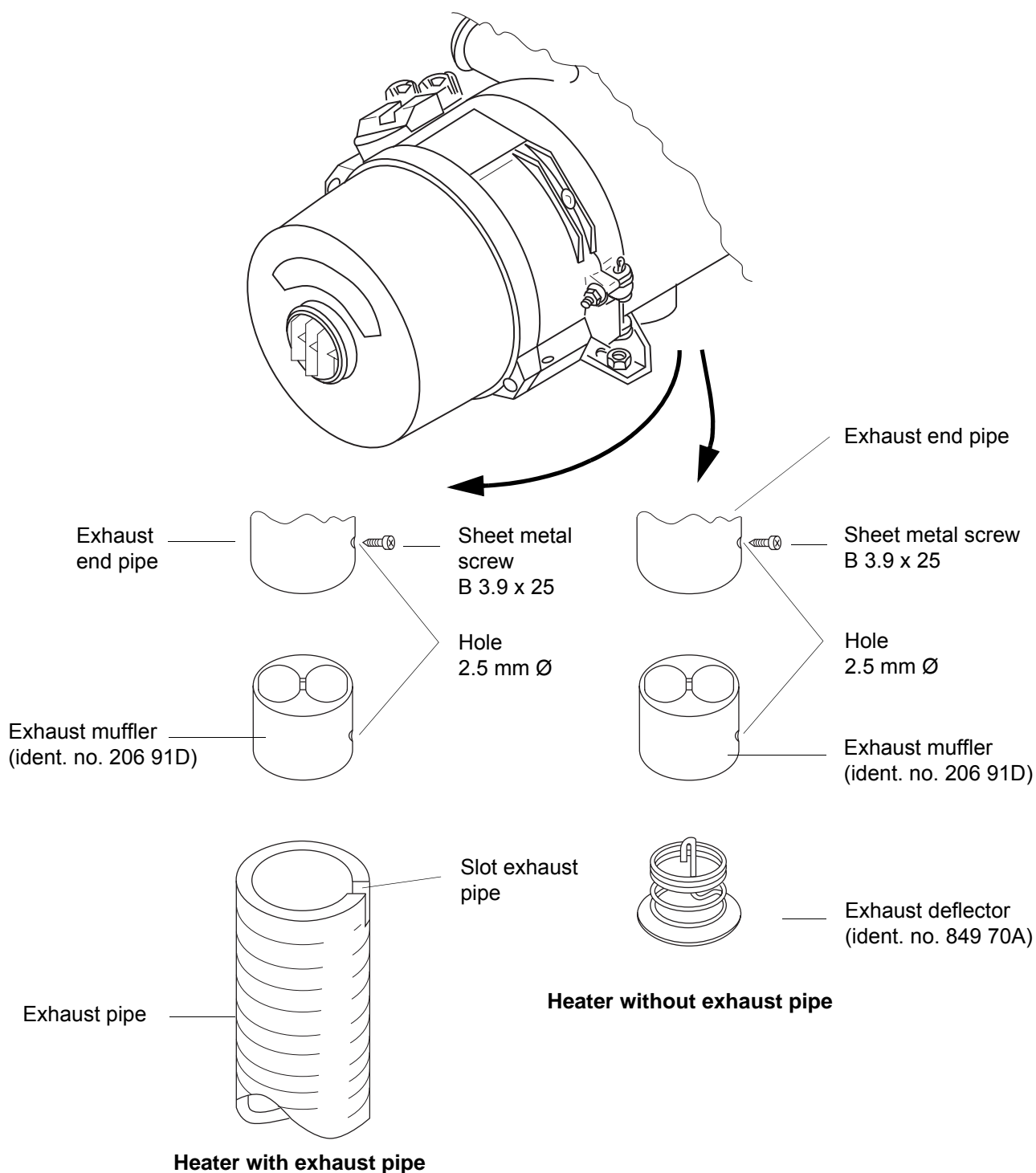


**Inspection and Attachment****NOTE**

The exhaust muffler must always be secured with a sheet metal screw. Drill a hole with a diameter of 2.5 mm into the exhaust end pipe and muffler and arrest muffler with a sheet metal screw B 3.9 x 25 (see figure).

1. Check exhaust end pipe for presence of muffler.  
For checking remove exhaust end pipe as required.
2. If muffler is found in exhaust end pipe fasten as described in NOTE. Slot or drill exhaust end pipe and refit.

3. If no muffler is found in exhaust end pipe check if muffler is upstream in exhaust pipe. If muffler is dislocated in the exhaust pipe, arrest muffler as described in NOTE. Slot or drill exhaust pipe and refit.
4. If the exhaust muffler has been lost it may be ordered from Spheros (ident. no. 206 91D). Fasten muffler according to NOTE. Slot or drill exhaust pipe and refit.
5. If heater is operated without exhaust pipe, fasten muffler according to NOTE. An exhaust deflector (ident. no. 849 70A) must be additionally fitted.



### 8.5.2 Burner Head Opening and Closing or Removal and Installation

#### WARNING

The igniter box operates with high voltage. Prior to opening the burner head the connectors of the cable harness in the vehicle have to be disconnected to prevent lethal injuries.

After closing and fixing burner head, reconnect connectors in the vehicle.

#### NOTE

Maintenance on the heater is easy. By swinging the burner head open the following components become accessible:

- fuel pump and fuel nozzle
- solenoid valve
- igniter box
- igniter electrodes
- flame sensor
- combustion chamber
- nozzle block preheater (if installed)

In order to obtain a convenient burner head opening angle it is required to disconnect the electrical connection(s) to the temperature limiter and temperature sensor.

#### Opening or removal

1. Disconnect electrical connections to temperature limiter and temperature sensor.
2. Loosen nuts (3, Fig. 801) enough to release hinge bolts (2).
3. Swing hinge bolts (2) out.
4. Swing burner head (4) open.
5. Remove cotter pin (1) as required to remove burner head.

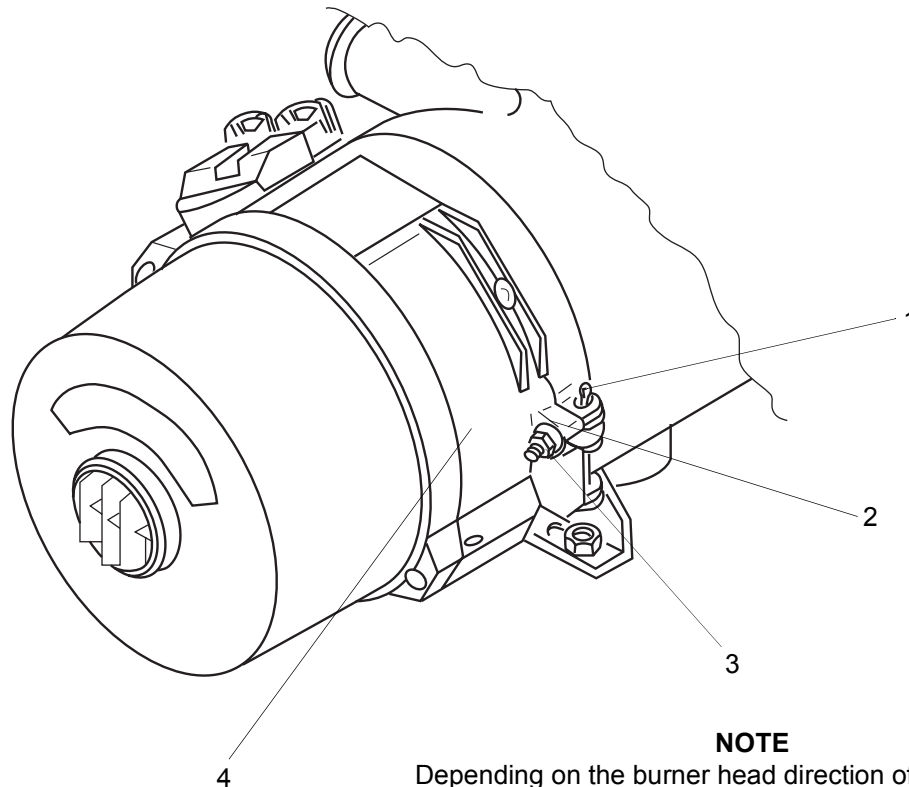
#### Closing or installation

1. As required fasten burner head (4, Fig. 801) in position using cotter pin (1).
2. Swing burner head (4) closed and locate for assembly.
3. Swing hinge bolts (2) into lock position and secure with nuts (3).
4. Torque nuts (3) with 7.5 Nm + 1 Nm.
5. Reconnect electrical connections to the temperature limiter and temperature sensor.

#### NOTE

When making electrical connections observe wiring color codes.

- 1 Cotter pin
- 2 Screw (2)
- 3 Nut (2)
- 4 Burner head



#### NOTE

Depending on the burner head direction of swing the cotter pin may be located on the opposite side.

Fig. 801 Swinging Burner Head open

## 8.6 Visual Inspections and Regulations for Installation

### 8.6.1 Connection to Vehicle Cooling System

The installation of the heater should be in a location as low as possible to ensure self-venting of the heater and circulation pump. This applies in particular for the circulation pump because it is not self-sucking.

The heater is to be connected to the vehicle cooling system according to Fig. 802. The cooling system coolant capacity must be at least 10 liters.

The vehicle cooling system or the separate heating circuit must use only pressure relief valves with an opening pressure of at least 0.4 bar and of max. 2.0 bar.

It is a basic requirement to use the coolant hoses supplied by Spheros, otherwise the hoses must at least meet the specifications of DIN 73411. The hoses have to be installed free of kinks and for proper venting in an inclination. Hose connections must be secured against slippage with hose clamps.

#### NOTE

The specified tightening torques of the hose clamps used must be complied with.

Prior to the heater's first operation or after replacement of the coolant, attention must be paid to carefully bleed the cooling system. Heater and lines must be installed so that static venting is guaranteed.

Improper venting may cause malfunctions by overheating in equipment operation.

Proper venting may be identified by a circulation pump almost noiseless in operation.

When using the circulation pump Aquavent 6000 (U4851) or Aquavent 6000S (U4852) or Aquavent 6000SC (U4856) the circulation pump automatically is switched off approx. 15 seconds after switch-on if coolant is lacking or the pump wheel is jammed.

In combination with control unit 1572D (Thermo label colored) and with programmed circulation pump check the heater also switches off when coolant is missing.

### 8.6.2 Connection to Vehicle Fuel System

Fuel is tapped from the fuel reservoir of the vehicle or from a separate fuel tank.

#### 8.6.2.1 Fuel Lines

In order to avoid air from being captured in fuel lines, they should only be installed with an incline. The fuel line joints are to be secured against slipping with hose clamps should no screwed mechanical unions be in use.

Should fuel hoses be installed always use the hoses supplied or offered by Spheros. If other hoses are used they must at least meet the specifications of DIN 73379. Fuel hoses must not be kinked or twisted and must be secured with clamps every 25 cm.

For routing fuel also fuel lines may be used consisting of materials standard in the manufacturing of vehicles, e.g. steel, copper or plastic lines made of unhardened, light and temperature stabilized PA11 or PA12 (e.g. Mecanyl RWTL) according to DIN 73378 observing the applicable jointing instructions.

Basic rules for the routing of fuel lines are:

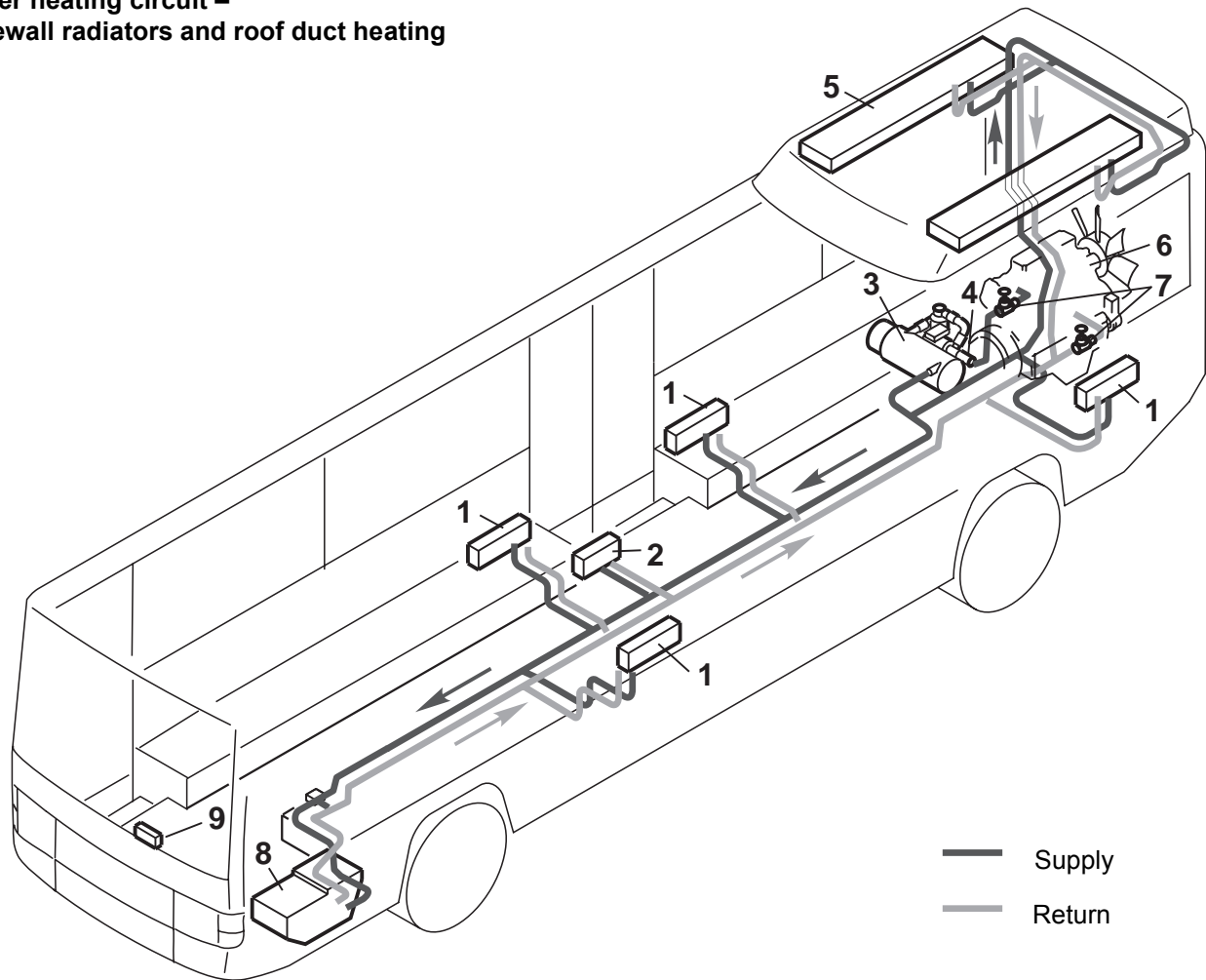
- Protect against undue temperatures.

#### WARNING

In overheat condition the heater outer shell may reach Diesel fuel inflammation temperature!

- Protect lines from stone strike.
- **Dripping or evaporating fuel may neither accumulate nor ignite on hot components or electrical equipment.**

**Water heating circuit –  
Sidewall radiators and roof duct heating**



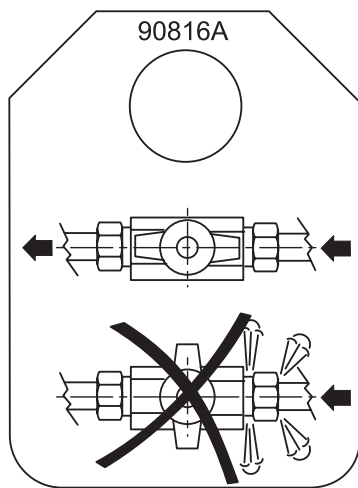
- 1 Sidewall radiator with fan
- 2 Heat exchanger, entrance
- 3 Heater unit
- 4 Circulation pump
- 5 Heat exchanger, roof
- 6 Vehicle engine
- 7 Cockpit heating
- 8 Control element

Fig. 802 Example of a Heater Installation in a Passenger Bus

When installing a shut-off device in the return line a clearly visible information label must be provided.

### CAUTION

Operation with the return line shut off causes damage to the fuel pump. Fuel may escape. Danger of fire.



Information label

Loose fuel lines must be secured in order to avoid sagging.

The installation of an additional fuel pump is not allowed.

Fuel lines permissible dimensions:

- inner diameter for suction and return line: 6 mm (other diameters upon request).
- max. permissible length for each suction and return line: 10 m
- Max. permissible suction height: 2 m
- Max. permissible priming pressure: 0.3 bar for suction and return line.

### 8.6.2.2 Fuel Filter

A fuel filter supplied as deliverable item or cleared for use by Spheros is to be fitted.

Installation position possibly vertical with horizontal direction of flow. To avoid operating malfunctions replace filter or filter cartridge once a year or more often if fuel is contaminated.

### 8.6.3 Combustion Air Supply

#### CAUTION

Observe official regulations concerning the installation (see 1.6).

Combustion air must under no circumstances be extracted from rooms with persons. The combustion air inlet must not point towards the forward direction of motion.

It must be located so that no clogging by contamination, impact of snow, or intake of splash water is to be expected.

The combustion air intake and exhaust outlet is to be located so that no air pressure difference builds up in any operating condition of the vehicle.

Permissible dimensions of combustion air intake line:

- inner diameter: 55 mm
- max. length: 5 m without the exhaust extension
- max. bend: 270°

The combustion air inlet must be located so that no exhaust fumes can enter.

#### NOTE

If the combustion air intake line cannot be routed upwards to the heater, a water drain hole Ø 4 mm is to be provided at the lowest point.

If the heater is located near the fuel tank in a common installation compartment, combustion air must be taken in from and the exhaust routed to the exterior. The feedthroughs must be sealed against splash water.

If the heater is located in a closed installation box, a vent port is required:

Thermo 230, 231, 300 and 301	30 cm <sup>2</sup>
Thermo 350	35 cm <sup>2</sup>

If the temperature in the installation box exceeds the permitted ambient temperature of the heater (see Technical Data), the vent port must be enlarged consulting Spheros.

### 8.6.4 Exhaust Line

#### CAUTION

Observe official regulations concerning the installation (see 1.6).

The exhaust pipe outlet opening must not point in the direction of motion.

The exhaust pipe outlet opening must be located so as not to expect clogging by snow or mud.

The combustion air intake and exhaust outlet is to be located so that no air pressure difference builds up in any operating condition of the vehicle.



Rigid pipes made of unalloyed or alloyed steel with a minimum wall thickness of 1.0 mm have to be used as exhaust line or flexible pipes made of alloyed steel only. The exhaust pipe is secured to the air heater e.g. with a clamp.

Permissible exhaust line dimensions:

- inner diameter: 70 mm
- max. length: 5 m without the exhaust extension
- max. bend: 270°

As an alternative an exhaust deflector must be installed cleared by Spheros.

## **8.7 Removal and Installation**

### **CAUTION**

In installed condition only the following disassembly or removal procedures are permitted should enough space for removal allow such action:

- replacement of temperature limiter
- replacement of temperature sensor
- replacement of combustion air fan
- replacement of burner
- replacement of igniter box
- replacement of flame sensor
- replacement of combustion chamber

### **8.7.1 Heater, Removal and Installation**

#### **8.7.1.1 Removal**

1. Disconnect connectors of cable harness in vehicle and of circulation pump.
2. Disconnect combustion air intake on heater if required.
3. Loosen clamp on exhaust outlet.
4. Loosen fuel supply and return line connections and fit dummy plugs.  
Close water cocks as applicable.
5. Loosen hose clamps on coolant hoses, disconnect hoses and fit dummy plugs.
6. Remove 3 screws and washers or 4 screws and washers.
7. Remove heater.

#### **8.7.1.2 Installation**

1. Locate heater for installation and secure with 3 screws and washers or 4 screws and washers.
2. Secure line on exhaust outlet using clamp.
3. Slide on coolant hoses and fasten with hose clamps. Torque clamps with 1.5 Nm. Open water cocks.
4. Connect fuel supply and return lines and tighten connections or screw tight with banjo bolt and new gaskets.

5. Secure combustion air inlet line on heater as applicable.
6. Connect electrical connectors of cable harness in vehicle and to circulation pump.
7. Bleed fuel supply system.
8. Bleed coolant circuit.

### **8.7.2 Temperature Limiter, Replacement**

#### **NOTE**

The replacement procedure for the temperature limiter is identical with the heater installed or removed. Perform replacement in accordance with 9.2.1.

### **8.7.3 Temperature Sensor, Replacement**

#### **NOTE**

The replacement procedure for the temperature sensor is identical with the heater installed or removed. Perform replacement in accordance with 9.2.2.

#### **WARNING**

Prior to replacement of temperature sensor in installed condition relief overpressure in cooling system by opening the cooling circuit sealing element.  
If required also allow heater to cool down and have collector vessel ready to collect escaping coolant.

### **8.7.4 Burner, Replacement**

#### **NOTE**

The replacement procedure for the burner is identical with the heater installed or removed. Perform replacement in accordance with 9.2.3.

#### **WARNING**

The igniter box operates on high voltage. Prior to replacement of burner disconnect electrical connectors of cable harness in vehicle to avoid lethal accidents.

### **8 7.5 Igniter Box, Replacement**

#### **NOTE**

The replacement procedure for the igniter box is identical with the heater installed or removed. Perform replacement in accordance with 9.2.7.

#### **WARNING**

The igniter box operates on high voltage. Prior to replacement of igniter box disconnect electrical connectors of cable harness in vehicle to avoid lethal accidents.

**8.7.6 Flame Sensor, Replacement****NOTE**

The replacement procedure for the flame sensor is identical with the heater installed or removed.  
Perform replacement in accordance with 9.2.8.

**WARNING**

The igniter box operates on high voltage. Prior to replacement of flame sensor disconnect electrical connectors of cable harness in vehicle to avoid lethal accidents.

**8.7.7 Combustion Chamber, Replacement****NOTE**

The replacement procedure for the combustion chamber is identical with the heater installed or removed.  
Perform replacement in accordance with 9.2.10.

**WARNING**

The heater operates on high voltage. Prior to replacement of combustion chamber disconnect electrical connectors of cable harness in vehicle to avoid lethal accidents.

**8.8 First Operation**

After heater installation the coolant circuit and the fuel supply system must be thoroughly bled observing the vehicle manufacturer's instructions. During test runs all coolant and fuel line connections have to be checked for security and no leakage. Should the heater in operation enter a fault condition, perform troubleshooting (refer to Section 5).

**NOTE**

Heaters with control unit 1572D:  
If the heater performs 5 subsequent attempts to start due to a malfunction, the heater enters an error lockout and stops any further attempts to start. This error lockout is superior to the normal error lockout condition.  
The error lockout reset is achieved by switching the heater on and disconnection of the heater power supply within 120 sec. during run-down.

**8.8.1 Water Circuit, Bleeding****NOTE**

Bleeding must always be performed in accordance with manufacturer's instructions. For bleeding the circulation pump must not be switched on.

Set vehicle own heating system to "warm" and replenish coolant which must consist of at least 10 % anti-freeze (on glycol base) (protection against corrosion). When using pure water there will be no protection against corrosion and due to the lower boiling point of the water when overheating loss of cooling water may result requiring continuous replenishment. Additives in the coolant must not affect metals, plastics or rubber and leave no deposits.

Then operate engine at increased idle until radiator thermostat opens. Shut down engine, check coolant level and replenish as required.

Switch on heater and vehicle heating fan with engine shut down. After a certain cool-down period the heater must automatically switch on and control to off. In case of no restart attempt the temperature limiter on the heater has responded because the heater has not been bled properly. Reset temperature limiter (push button on temperature limiter) and repeat complete bleeding procedure.

**NOTE**

The heater may be equipped with an automatically resetting temperature limiter. The manual reset is not necessary.

**8.8.2 Fuel Supply System, Bleeding**

The whole fuel supply system including the fuel filter must completely filled with fuel before initial start-up.

**NOTE**

Never use the fuel pump to fill / bleed the fuel system!

**ATTENTION**

In the event no fuel comes to the fuel pump during initial start-up, there is a risk that the fuel pump will be damaged!

## **9 Repair**

### **9.1 General**

This section describes the repairs that may be performed on the heaters *Thermo 230, 231, 300, 301* and *350* when removed. Any further disassembly will void the warranty. For re-assembly only components of the proper spare part kits are to be used.

#### **WARNING**

The igniter box operates on high voltage. The following components may also be replaced with the heater installed unless restricted space prevents access:

- temperature limiter
- temperature sensor
- combustion air fan
- burner
- igniter box
- flame sensor
- combustion chamber

Prior to replacement disconnect connectors of cable harness in vehicle to avoid lethal accidents.

#### **WARNING**

Hot coolant may escape during the replacement of the temperature sensor.

Before replacing the temperature sensor also release pressure from cooling system by opening sealing element.

If required also allow heater to cool down.

**9.1.1 Work on Components after Disassembly****CAUTION**

All gaskets located between disassembled components must always be replaced and discarded.

**9.1.1.1 Visual Inspection, General**

- Examine all components for damages (cracks, deformation, wear, etc.) and replace as necessary.
- Examine connectors and wiring for corrosion, loose contacts, wrong crimping, etc. and repair as necessary.
- Check terminals for corrosion and contacts for security. Repair as required.

**9.1.1.2 Combustion Chamber, Visual Inspection**

- Check swirl ring for security.
- Inspect combustion chamber for oxidizing and coke deposits and remove as required.
- Check welding seem for cracks.

**NOTE**

Longitudinal cracks up to 80 mm are allowed.

**9.1.1.3 Heat Exchanger, Visual Inspection**

- Inspect exhaust ducting in heat exchanger for sooting, deposits, damage and corrosion.

**NOTE**

Deposits are to be removed with water jet and brush.

- Inspect heat exchanger for exterior damage, deformation, etc.

**NOTE**

Heavy deformation may cause restricted flow of coolant.

**CAUTION**

When replacing the combustion chamber on heaters installed vertically, remove deposits in heat exchanger using a suitable tool.

**9.1.1.4 Combustion Air Fan Wheel, Visual Inspection**

- Check fan wheel for contamination and cracks.
- Check cover plate for security.
- Check slide lock for proper sealing.

**9.1.2 Incorporation of Modifications****NOTE**

Continuous enhancement of heater design is for optimizing performance and avoiding failures and malfunctions. Normally equipment in use may be retrofitted using available modification kits

The following modifications may be incorporated during repair procedures:

- installation of control unit 1572D as substitute for control unit 1572 (see 9.1.2.1)

### 9.1.2.1 Installation of Control Unit 1572D as Substitute for Control Unit 1572

#### General

Due to the progress in the development of processors control unit 1572 can no longer be supplied. The retrofit of control unit 1572D is performed according to the following procedure:

The modification kit consists of:

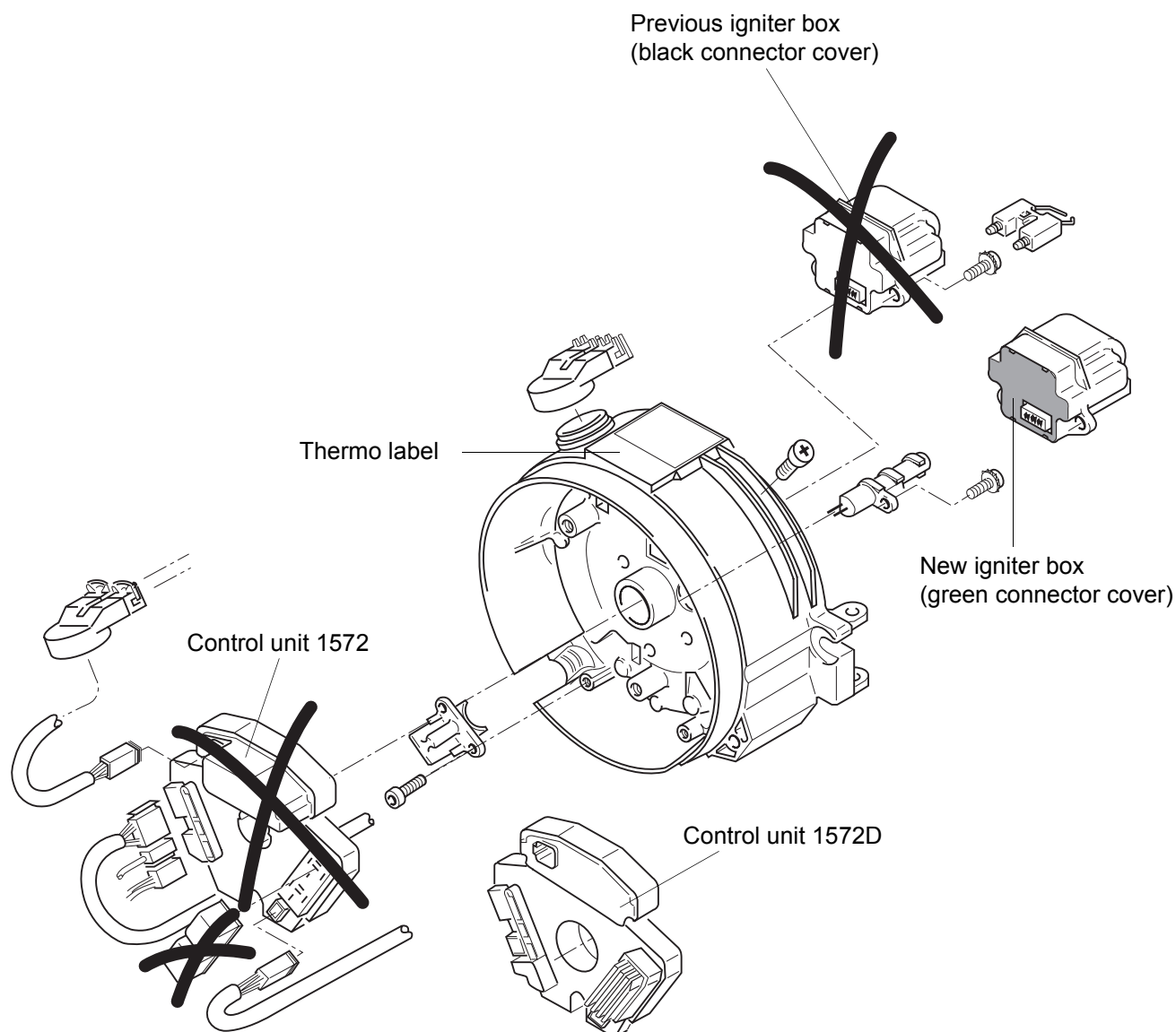
- control unit 1572D
- igniter box
- thermo identification label

#### Procedure

#### CAUTION

Control unit 1572D may only be used in combination with the igniter box delivered (green connector cover). The electrical connector is coded.

1. Remove control unit according to 9.2.5.1 and discard.
2. Remove igniter box according to 9.2.7.1 and discard.
3. Install new igniter box according to 9.2.7.2.
4. Install new control unit according to 9.2.5.2.
5. Apply new thermo label onto existing label to indicate retrofit.



## 9.2 Disassembly and Assembly

### 9.2.1 Temperature Limiter, Replacement

#### 9.2.1.1 Removal

1. Disconnect electrical connection to temperature limiter.
2. Withdraw rubber cap. Using screw driver lever off retaining spring and remove temperature limiter (1, Fig. 901).

#### 9.2.1.2 Installation

1. Slide rubber cap of temperature limiter (1, Fig. 901) back until temperature limiter can be located for installation.
2. Position temperature limiter (1) in connector (3) and push in retaining clip.

#### WARNING

The retaining spring must be located in the groove of the housing and must be latched in position both perceptibly and audibly (twice) at the collar of the locating socket. Only then will the temperature limiter be in proper contact with the heat exchanger jacket.

3. Fit rubber cap.  
After the rubber cap has been placed in position, the cable must be aligned in the cable sleeve, free from strain.  
Connection cables must not be routed over reset button.

#### NOTE

Observe electrical wiring color coding when making connections to temperature limiter.

4. Make electrical connections.

### 9.2.2 Temperature Sensor, Replacement

#### 9.2.2.1 Removal

1. Disconnect electrical connection to temperature sensor.

#### WARNING

Prior to replacement of temperature sensor in installed condition relief overpressure in cooling system by opening the cooling circuit sealing element.  
If required also allow heater to cool down and have collector vessel ready to collect escaping coolant.

2. Unscrew temperature sensor (2, Fig. 901) and remove.

#### 9.2.2.2 Installation

1. Manually screw temperature sensor (2, Fig. 901) into coolant outlet (4).
2. Torque temperature sensor to 20 Nm +5 Nm.
3. Restore electrical connections.

#### NOTE

Observe electrical wiring color coding when making connections to temperature sensor.

### 9.2.3 Burner, Replacement

#### 9.2.3.1 Removal

1. Disconnect electrical connections on burner and loosen fuel lines.
2. Loosen nuts (6, Fig. 901) until hinge bolts are free.
3. Swing hinge bolts (7) open and remove cotter pin (5).
4. Remove burner (8).
5. Perform procedures on components after disassembly (refer to 9.1.1).

#### 9.2.3.2 Installation

1. Position burner (8, Fig. 901) for installation, swing hinge bolts closed and secure temporarily using screws (6).
2. Insert cotter pin (5) according to the intended opening swing direction.
3. Tighten nuts (6) with 7.5 Nm + 1 Nm.
4. Connect fuel lines.
5. Restore electrical connections.

#### NOTE

Observe electrical wiring color coding when making connections to temperature limiter and temperature sensor.

- 1 Temperature limiter
- 2 Temperature sensor
- 3 Connector
- 4 Coolant outlet
- 5 Cotter pin
- 6 Nut (2)
- 7 Hinge bolt (2)
- 8 Burner

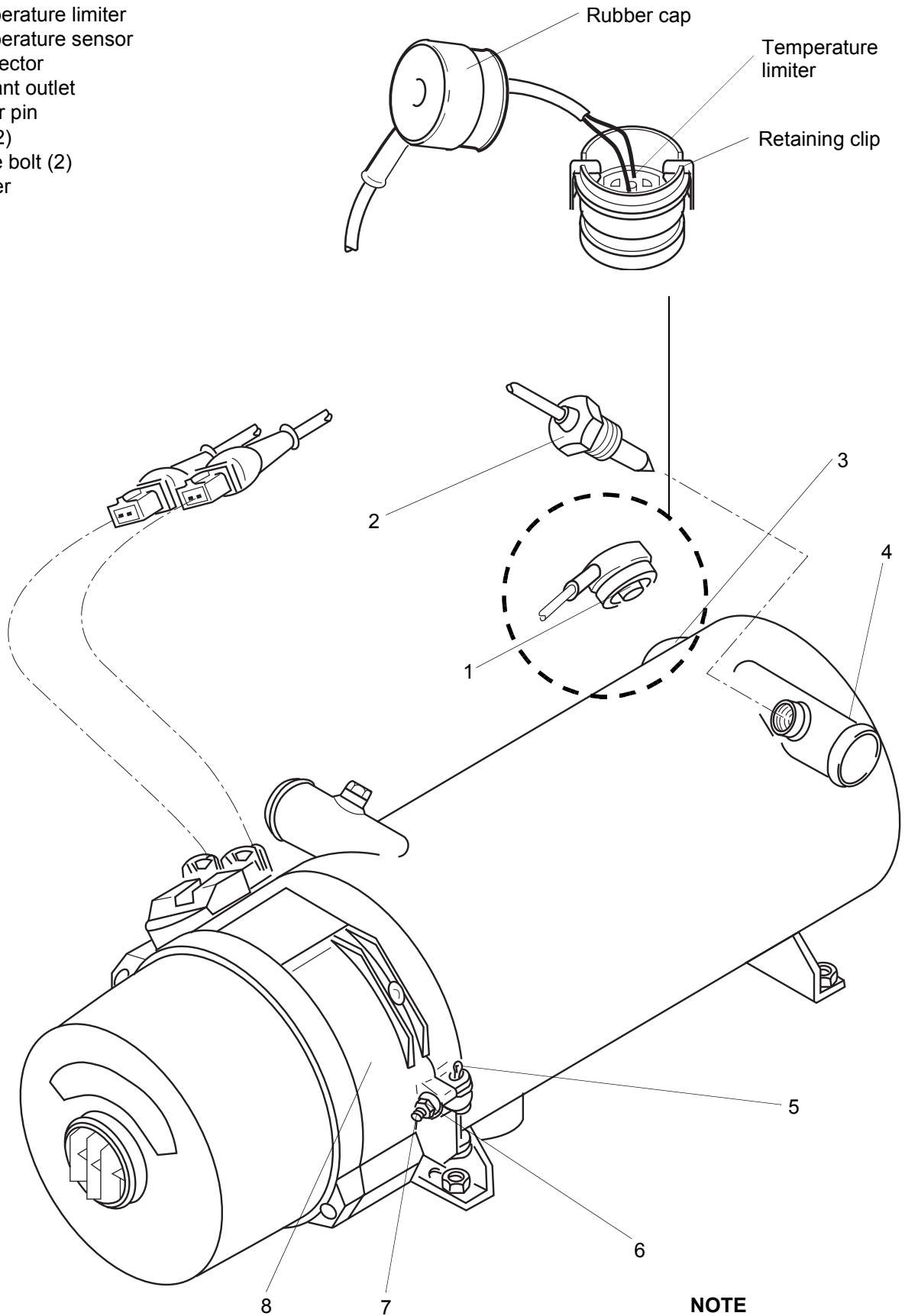


Fig. 901 Temperature Limiter, Temperature Sensor and Burner, Replacement

### 9.2.4 Combustion Air Fan, Replacement

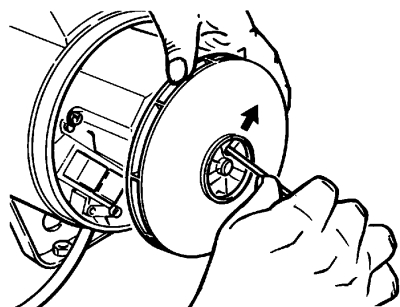
#### NOTE

For replacement of the combustion air fan the burner may be left installed.

In removed condition ensure that igniter electrodes are not bent and nozzle is not damaged.

#### 9.2.4.1 Removal

1. Loosen screws (3, Fig. 902) and withdraw cap (2) from burner.
2. Using suitable tool (e.g. mandrel 3 mm) open slide lock (5) until fan wheel can be pulled off.
3. Disconnect electrical connector (9).
4. Remove screws (6) with lock washers and withdraw fan motor (7).
5. Perform procedures on components after disassembly (refer to 9.1.1).



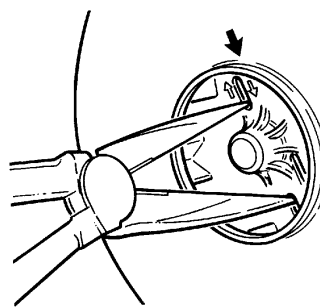
Opening slide lock

#### 9.2.4.2 Installation

#### NOTE

Fan motor (7, Fig. 902) to be aligned with control unit (recess in mounting flange) and with clutch (by rotating drive shaft).

1. Align fan motor (7) and position for installation.
2. Attach fan motor using screws (6) and lock washers.
3. Tighten screws with 5 Nm + 1 Nm.
4. Connect electrical connector (9).
5. Bring slide lock (5) on fan wheel in installation position.
6. Slide fan wheel onto drive shaft and using suitable tool (e.g. mandrel 3 mm or pliers) close slide lock until fan wheel is locked.
7. Locate cap (2) and secure with screws (3).
8. Tighten screws with 2 Nm.



Closing slide lock



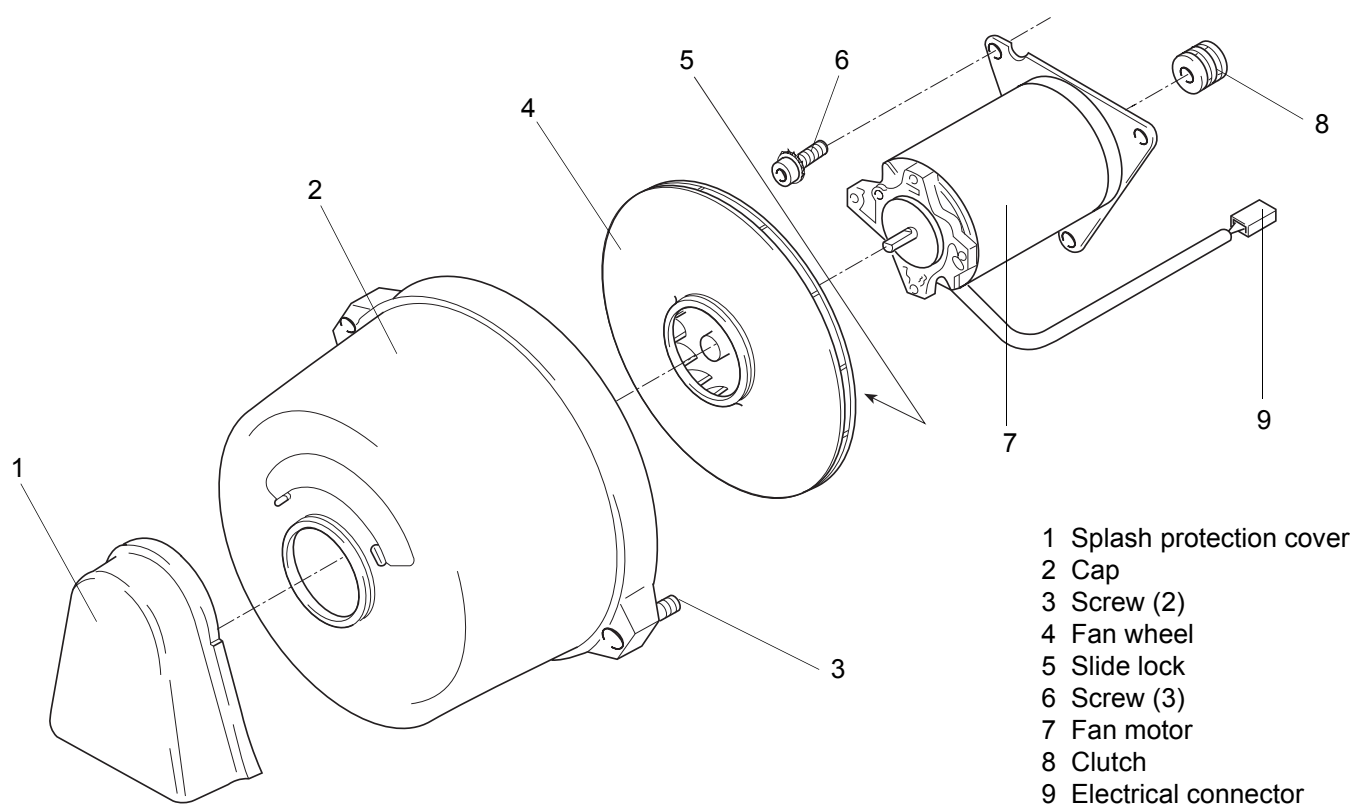


Fig. 902 Combustion Air Fan, Replacement

### 9.2.5 Control Unit, Replacement

#### NOTE

For replacement of the control unit the burner head may be left installed and must only be swung open for disconnection of electrical connector (8, Fig. 903). In removed condition ensure that igniter electrodes are not bent and nozzle is not damaged. If a control unit 1572 is substituted with a control unit 1572D, perform procedure according to 9.1.2.1.

#### 9.2.5.1 Removal

1. Disconnect all electrical connections from control unit (23, Fig. 903).
2. Swing burner head open (refer to 8.5.1) and disconnect electrical connector (8).
3. Remove flame sensor (refer to 9.2.8.1).
4. Remove combustion air fan (refer to 9.2.4.1).
5. Carefully withdraw control unit (23) in axial direction from burner head (17) and remove.
6. Perform procedures on components after disassembly (refer to 9.1.1).

#### 9.2.5.2 Installation

1. Carefully push control unit (23, Fig. 903) in axial direction against stop into burner head (17).
2. Install combustion air fan (refer to 9.2.4.2).
3. Make all electrical connections on control unit (23).
4. Install flame sensor (refer to 9.2.8.2).
5. Connect electrical connector (8).

### 9.2.6 Fuel Pump, Replacement

#### 9.2.6.1 Removal

1. Remove burner (refer to 9.2.3.1).
2. Using screwdriver lever off igniter electrodes (3, Fig. 903) from igniter box (1) and remove.
3. Remove disk (6, Fig. 903) with heating cartridge (if installed).
4. Disconnect electrical connector (8).

#### NOTE

During the following step ensure that escaping fuel is immediately neutralized and properly disposed of.

5. Remove screws (9) with lock washers.
6. Withdraw fuel pump (10) together with solenoid valve (7) and remove.
7. Remove and discard O-rings (12) and filter screen (11).
8. Remove solenoid valve (7) from fuel pump (10) as required.
9. Perform procedures on components after disassembly (refer to 9.1.1).

#### 9.2.6.2 Installation

1. Install solenoid valve (7, Fig. 903) on fuel pump (10) if required.
2. Fit new O-ring (12) and filter screen (11) on fuel pump (10).
3. Position fuel pump (10) for installation and secure with screws (9) and lock washers.
4. Tighten screws with 5 Nm + 1 Nm.
5. Connect electrical connector (8).
6. Plug on disk (6) and mount heating cartridge.
7. Plug on igniter electrodes (3, Fig. 904).
8. Install burner (refer to 9.2.3.2).

### 9.2.7 High Pressure Nozzle, Replacement

#### 9.2.7.1 Removal

1. Remove burner (refer to 9.2.3.1).
2. Using screwdriver lever off igniter electrodes (3, Fig. 903) from igniter box (1) and remove.
3. Remove disk (6, Fig. 903) with heating cartridge (if installed).
4. Disconnect electrical connector (8) of the heating cartridge.
5. Unscrew high pressure nozzle (4).

#### NOTE

Ensure cleanliness is maintained when installing the nozzle. Only touch the nozzle at its hexagon surface.

#### 9.2.7.2 Installation

1. Screw in high pressure nozzle (4, Fig. 903) and tighten with 20 Nm.
2. Connect electrical connector (8) of the heating cartridge.
3. Plug on disk (6) and mount heating cartridge.
4. Plug on igniter electrodes (3, Fig. 903).
5. Install burner (refer to 9.2.3.2).

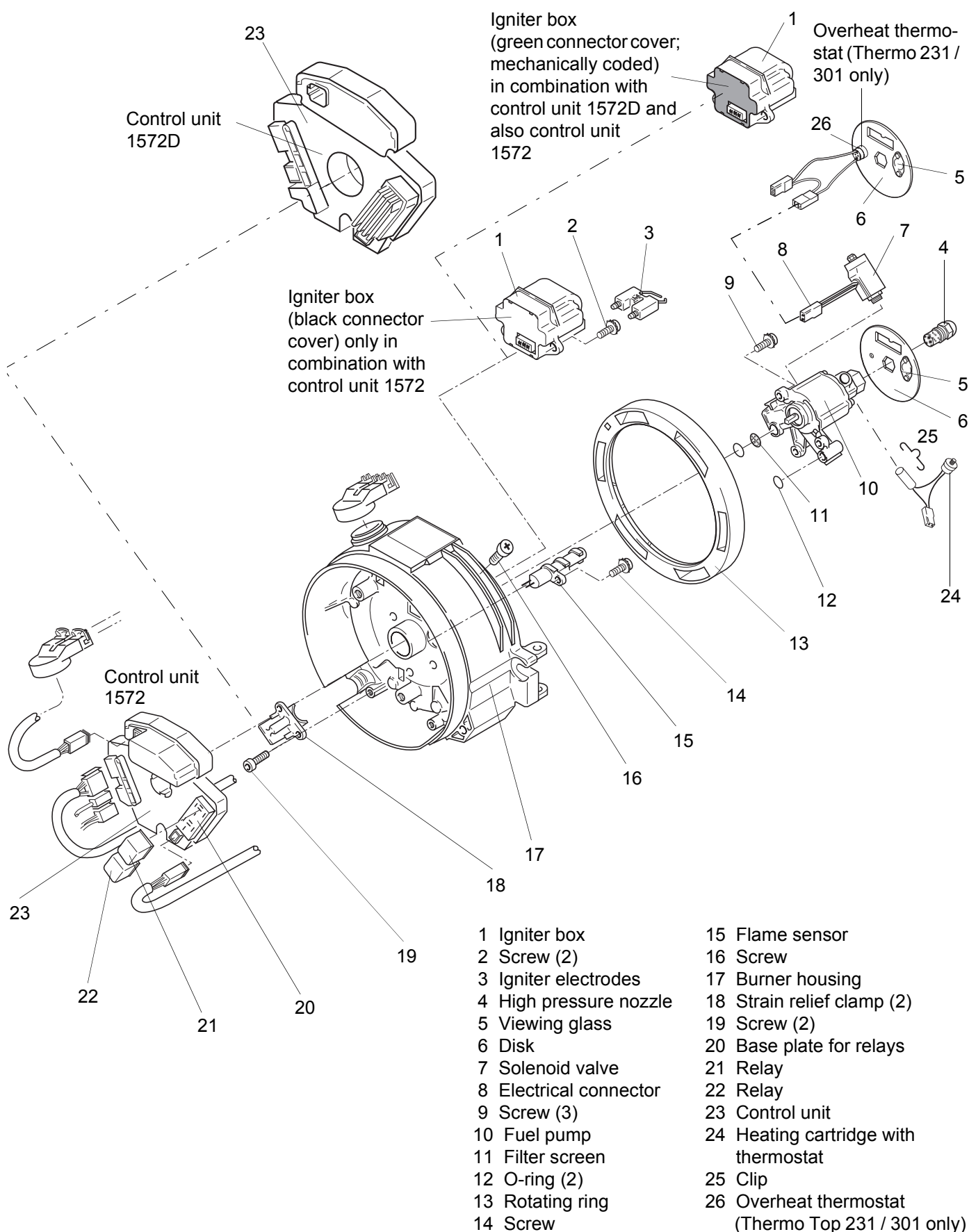


Fig. 903 Control Unit and Fuel Pump, Replacement

## 9.2.8 Igniter Box, Replacement

### 9.2.8.1 Removal

1. Remove burner if required (refer to 9.2.3.1).
2. Using screw driver lever off igniter electrodes (Fig. 904) from igniter box and remove.
3. Remove disk (6).
4. Remove screws (2) with lock washers.
5. Withdraw igniter box (1) and remove.
6. Perform procedures on components after disassembly (refer to 9.1.1).

### 9.2.8.2 Installation

1. Locate igniter box (1, Fig. 904) for installation, plug on making correct electrical connections and secure with screws (2) and lock washers.
2. Tighten screws (2) with 5 Nm + 1 Nm.
3. Plug on disk (6) and align.
4. Plug on igniter electrodes (3).
5. Install burner (refer to 9.2.3.2).

## 9.2.9 Flame Sensor, Replacement

### 9.2.9.1 Removal

1. Remove burner if required (refer to 9.2.3.1).
2. If required lever off igniter electrodes (Fig. 904) from igniter box using screw driver and remove.
3. Remove disk (6).
4. Remove screw (14) and lock washer.
5. Withdraw flame sensor (15) and remove.
6. Perform procedures on components after disassembly (refer to 9.1.1).

### 9.2.9.2 Installation

1. Position flame sensor (15, Fig. 904) for installation, plug on to make correct electrical connections and secure with screw (14) and lock washer.
2. Tighten screw (14) with 5 Nm + 1 Nm.
3. Plug on disk (6) and align.
4. Plug on igniter electrodes (3).
5. Install burner (refer to 9.2.3.2).

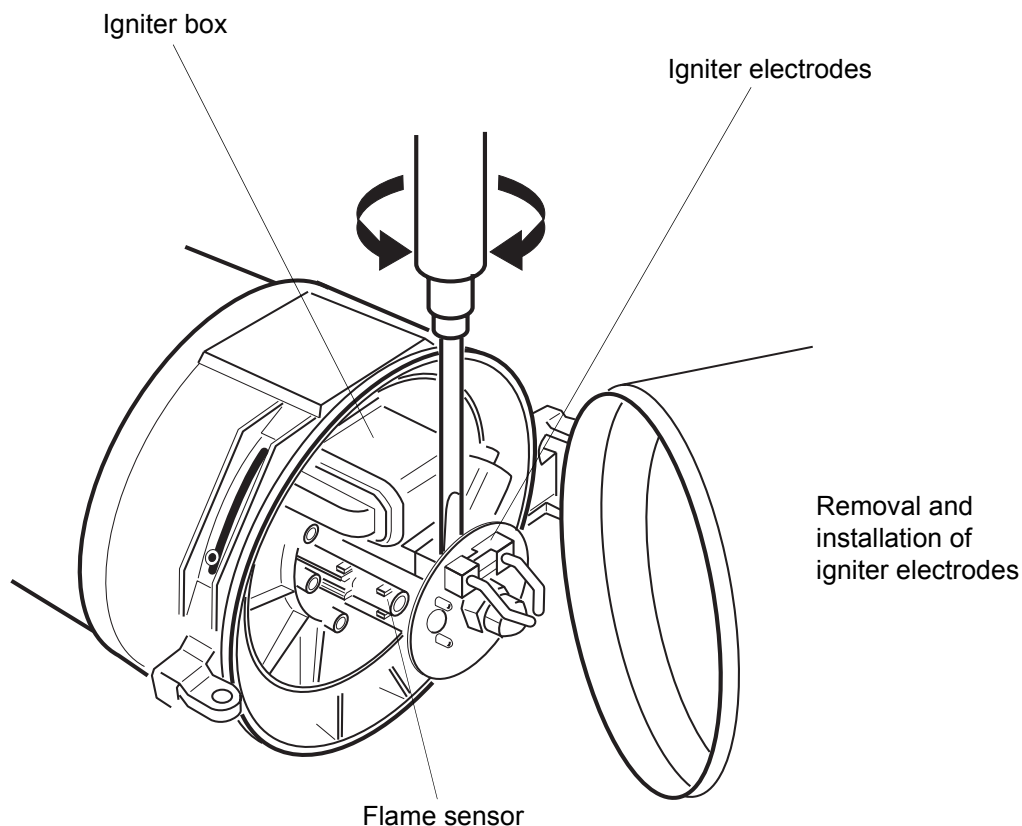


Fig. 904 Igniter Box and Flame Sensor, Replacement (Sheet 1 of 2)

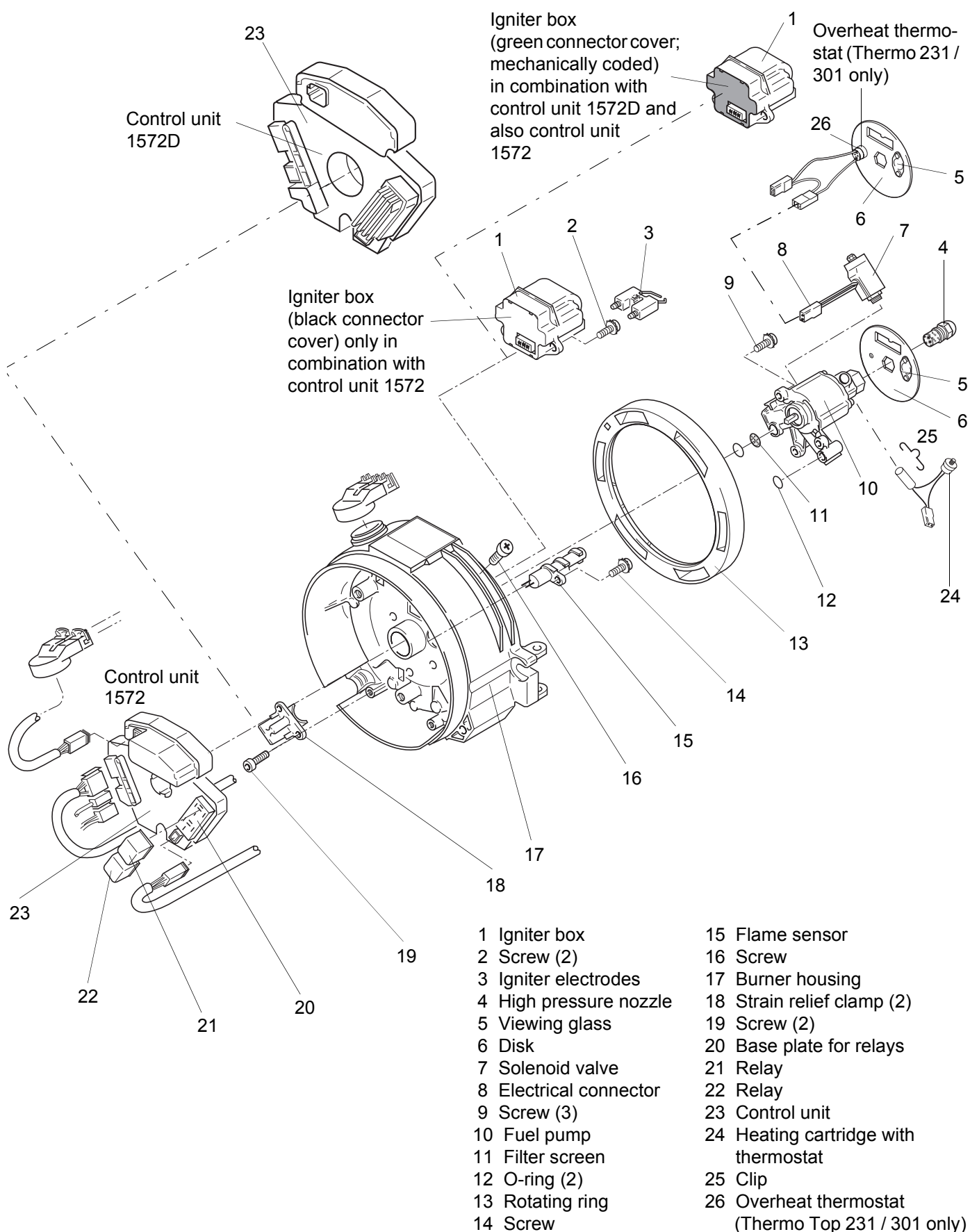


Fig. 904 Igniter Box and Flame Sensor, Replacement (Sheet 2 of 2)

**9.2.10 Heat Exchanger, Replacement****9.2.10.1 Removal**

1. Remove temperature limiter (refer to 9.2.1.1).
2. Remove temperature sensor (refer to 9.2.2.1).
3. Remove burner (refer to 9.2.3.1).
4. Withdraw combustion chamber (1, Fig. 905) from heat exchanger (2).
5. Remove heat exchanger (2).
6. Perform procedures on components after disassembly (refer to 9.1.1).

**9.2.10.2 Installation**

1. Slide combustion chamber (1, Fig. 905) fully into heat exchanger (2) against stop.
2. Install burner (refer to 9.2.3.2).
3. Install temperature limiter (refer to 9.2.1.2).
4. Install temperature sensor (refer to 9.2.2.2).

**9.2.11 Combustion Chamber, Replacement****9.2.11.1 Removal**

1. Disconnect electrical connections to temperature limiter and temperature sensor.
2. Swing burner open (refer to 8.5.2).
3. Withdraw combustion chamber (1, Fig. 905) from heat exchanger (2) and remove.
4. Perform procedures on components after disassembly (refer to 9.1.1).

**9.2.11.2 Installation**

1. Slide combustion chamber (1, Fig. 905) fully into heat exchanger (2) against stop.
2. Swing burner closed (refer to 8.5.2).

**NOTE**

Observe electrical wiring color coding when making connections.

3. Make electrical connections to temperature limiter and to temperature sensor.

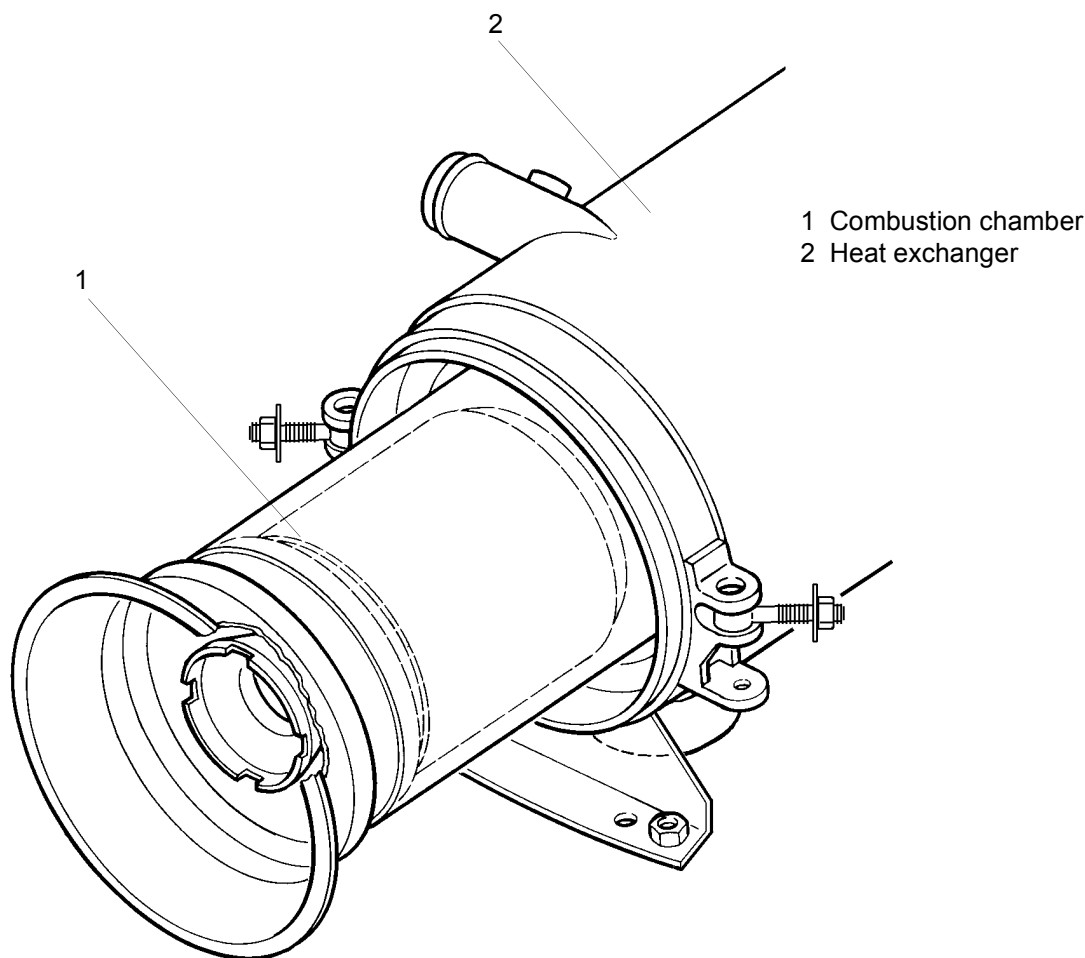


Fig. 905 Heat Exchanger and Combustion Chamber, Replacement

## **10 Packaging, Storage and Shipping**

### **10.1 General**

The heater or its components shipped to Spheros for testing or repair must be cleaned and packaged so that they are protected against damage during handling, shipping and storage.

#### **CAUTION**

When shipping a complete heater assembly it must be drained completely. No coolant is allowed to escape when packaging or shipping.

Dummy plugs must be fitted to the coolant inlet and outlet as well as to the fuel lines.

In storage the ambient temperatures specified in Section 4 must not be exceeded.





**Annex A**

**Scheduled Maintenance**

**Heater, Scheduled Maintenance \***

The heater should be checked in regular intervals at least at the beginning of the heating season (point of time when weather conditions cause increased use of heater).

The maintenance intervals indicated below apply to applications and requirements typical of busses. Should the heaters be used in other vehicles or applications, these intervals may have to be adapted, i.e. shortened or extended.

In these cases, please contact your Spheros partner charge.

Check / Maintenance	Important Notes	Check Result		Measured Values, Maintenance / Repair performed
		i.O.	nicht i.O.	
<b>1. Electrical connections</b> a) Disconnect electrical connectors to cable harness, inspect for oxidation, spray and reconnect after performing step 5. b) Inspect fuses for oxidation and/or check transitionresistances.	Use suitable contact spray, e.g. special contact spray (order no. 101322).	<input type="checkbox"/>	<input type="checkbox"/>	
<b>2. Heat exchanger</b> a) Inspect paint for dark stains of burn (local overheating). b) Check for signs of leakage. c) Clean heater exterior and interior.	If necessary investigate reason for overheating (e.g. water circuit). Check temperature limiter.	<input type="checkbox"/>	<input type="checkbox"/>	
<b>3. Fuel system</b> a) Check fuel lines and connections for leaks. b) Replace fuel filter cartridge with gasket. c) If existing, open fuel shut-off valves.  d) Fuel pump e) Replace fuel filter screen with gaskets in pump.	Check for leak-proof connections in fuel supply and return! Retighten joints and hose clamps.  Replace pump and lines every 5years.	<input type="checkbox"/>	<input type="checkbox"/>	
<b>4. Burner head</b> a) Check combustion air inlet for contamination. Swing burner head open: b) Check cover for damage c) Check housing interior for accumulation of fuel caused by leaks. d) Clean viewing glass of flame sensor. e) Check igniter electrodes for condition. f) Replace atomizer nozzle.	Replace damaged cover  Replace bent electrodes.  When coked reduce replacement interval for fuel filter.	<input type="checkbox"/>	<input type="checkbox"/>	
<b>5. Exhaust system</b> a) Check exhaust line for contamination and clean as required. b) Remove combustion chamber from heat exchanger, inspect both components for damage and contamination and clean or replace as required. c) Insert combustion chamber and mount burner head. Check for secure connection to heat exchanger. d) Restore electrical connections.		<input type="checkbox"/>	<input type="checkbox"/>	
<b>6. Water system</b> a) If installed, clean water filter. b) If installed, open water shut-off valves.		<input type="checkbox"/>	<input type="checkbox"/>	
<b>7. Functional checks</b> a) If installed, open shut-off valve in the return line. b) Check heater function. c) Check for smoke emissions in run-down; replace nozzle if required.	after at least 10 min. of heating operation.	<input type="checkbox"/>	<input type="checkbox"/>	

\* For rail applications consider the Maintenance Record RAIL 9008722B.

## Spheros-Service

Sie haben ein technisches Problem? Spheros bietet Ihnen in Zusammenarbeit mit Webasto ein weltweites Servicenetz!  
Spheros service telephone. Do you have a technical problem? Spheros offers in co-operation with Webasto a world-wide service net.



### Spheros

- (BR) Brasilien  
Spheros Brasil S.A.  
Tel. +55 54 21015700
- (CND) Canada  
Spheros North America,  
Inc., Canton, MI  
1-888-270-2226
- (RC) China  
Spheros (Yangzhou)  
Limited  
Tel. +86 514 5881 226
- (D) Deutschland  
Gilching  
Tel. +49 8105 7721 887  
[service@spheros.de](mailto:service@spheros.de)  
[www.spheros.de](http://www.spheros.de)
- (AE) Dubai  
Spheros Middle East  
Tel. +971 4 8860 665
- (FIN) Finnland  
Spheros Parabus Ltd.  
Tel. +358 2436 60 00
- (IND) Indien  
Spheros Motherson  
Thermal System Limited  
Tel. +91 120 4346154
- (MY) Malaysia  
Spheros (M) SDN BHD  
Tel. +60 3 8961 5606
- (MEX) Mexiko  
Spheros Mexico  
Tel. +52 728 2 84 01 64
- (P) Portugal  
Spheros Europa Iberica  
E-17451 Sant Feliu de  
Buixalleu, Girona  
Tel. +34 972 874 923

### Spheros

- (TR) Türkei  
Spheros Thermo  
Sistemleri A.S.  
Tel. +90 212 672 47 72
- (E) Spanien  
Spheros Europa Iberica  
E-17451 Sant Feliu de  
Buixalleu, Girona  
Tel. +34 972 874 923
- (USA) USA  
Spheros North America,  
Inc., Canton, MI  
1-888-270-2226
- (ZA) Südafrika  
Spheros SA (Pty) Ltd.  
Tel. +27 21 761 9971
- (UA) Ukraine  
Spheros Elektron  
GU GmbH  
Tel. +38 032 291 37 63

### Webasto-Europa

- (A) Österreich  
1230 Wien  
Tel. +43 1 6043780
- (B) Belgien  
8263 BC Kampen (NL)  
Tel. +31 38 3371 137
- (BIH) Bosnien-Herzegowina  
siehe Slowenien
- (BG) Bulgarien  
1839 Sofia  
Tel. +359 2 9420-555
- (BY) Weißrussland  
220004 Minsk  
Tel. +37 50172201894

### Webasto-Europa

- (HR) Kroatien  
siehe Slowenien
- (CH) Schweiz  
4123 Allschwil/BL  
Tel. +41 61 4869580
- (CZ) Tschechien  
140 00 Praha 4  
Tel. +420 2 41045450-7
- (DK) Dänemark  
DK-2610 Rødovre  
Tel. +45 44 522000
- (EE) Estland  
11214 Tallinn  
Tel. +372 651 9309
- (LV) Lettland  
1004 Riga  
K. Ulmana gatve 2  
Tel. +371 7807873
- (LT) Litauen  
2300 Vilnius  
Jočioniu g. 14  
Tel. +370 5 275 81 81
- (F) Frankreich  
91280 Tigery  
Tel. +33 (0) 169 138383
- (GB) Großbritannien  
Dn4 5JH Doncaster  
Tel. +44 1302 322232
- (GR) Griechenland  
10442 Athen  
Tel. +30 210 5196800
- (H) Ungarn  
1135 Budapest  
Tel. +36 1 3502337
- (I) Italien  
40062 Molinella (BO)  
Tel. +39 051 690 6131

### Webasto-Europa

- (IS) Island  
210 Gardabaer  
Tel. +354 5672330
- (KZ) Kasachstan  
480019 Almaty  
Tel. +7 3272 312650
- (L) Luxemburg  
8263 BC Kampen (NL)  
Tel. +31 38 3371 137
- (MK) Mazedonien  
siehe Slowenien
- (NL) Niederlande  
8263 BC Kampen  
Tel. +31 38 3371137
- (N) Norwegen  
1386 Asker  
Tel. +47 66 753000
- (PL) Polen  
05-092 Lomianki  
Tel. +48 22 7517787
- (RO) Rumänien  
075100, Otopeni, Ilfov  
Tel. +40 730 084 562
- (RUS) Russland  
107 065 Moscow  
Tel. +7 095 7770245
- (SRB) Serbien und  
Montenegro  
siehe Slowenien
- (CC) Slowakische Republik  
04012 Košice  
Tel. +421 55 7871000
- (SK) Schweden  
19181 Sollentuna/  
Stockholm  
Tel. +46 8 923000

### Webasto-Europa

- (SLO) Slowenien  
1000 Ljubljana  
Tel. +386 1 2008710

### Webasto-Amerika

- (RA) Argentinien  
1424 Buenos Aires  
Tel. +54 11 45242117
- (RCH) Chile  
OF907 Santiago de Chile  
Tel. +56 22 344311

### Webasto-Asien

- (RC) China  
Beijing  
Tel. +852 28 118230
- (J) Japan  
J-222-0033 Yokohama  
+81 45 4741761
- (ROK) Korea (Rep.)  
626-140 Yangsan-si,  
Gyeongsangnam-do  
Tel. +82 55 781 1002
- (MGL) Mongolei  
Ulaanbaatar  
Tel. +976 11 318138

### Webasto-Australien

- (AUS) Australien  
2232 NSW Kirrawee  
Tel. +61 2 85364800
- (NZ) Neuseeland  
2232 NSW Kirrawee  
Tel. +61 2 85364800

Für diese Druckschrift wurde ein  
umweltschonendes, aus 100%  
chlorfrei gebleichtem Zellstoff  
hergestelltes Papier verwendet.

Printed in Germany · 12.12  
Druck: Steffendruck Friedland

Änderungen vorbehalten  
Subject to modification  
Sous réserve de modifications

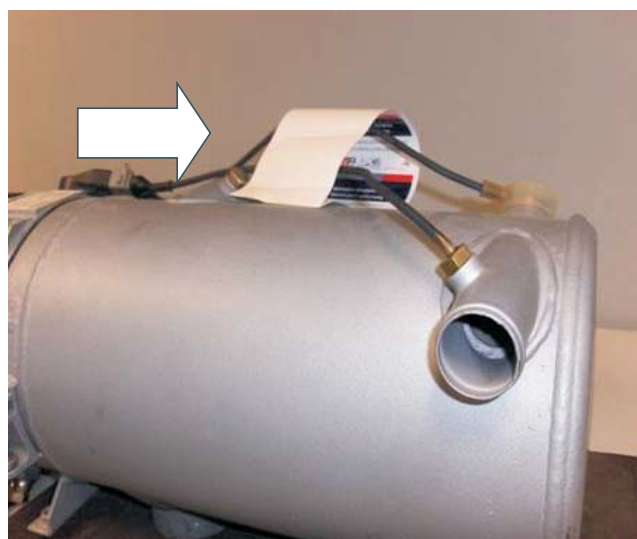
© Spheros GmbH

### Observance and affixing of the placard "Switch off auxiliary heating system before refuelling"

Statutory regulations require that this placard, in the respective language of the destination country, shall be affixed by the bus manufacturer near the fuel filler.

The bus operator shall observe this note categorically.

The placard in 9 languages and in the new Spheros-Design is provided **with each by the factory delivered SPHEROS-Heater** since 21.07.08 as depicted. The placard strip is attached securely to the heater by means of a clip as shown below and is to be removed before installation.



Prepared on 21.07.08

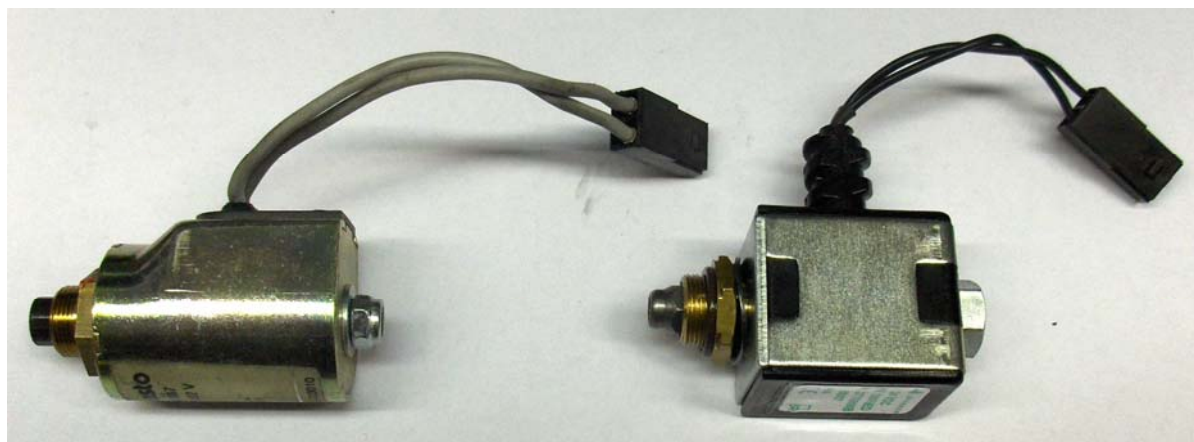
### Usage of the spare parts bag „Small parts for magnetic coil cpl.“, ident. no. 386650Z for heaters and spare parts note for the new solenoid valve 2710806B

Please consider that the spare parts bag “Small parts for magnetic coil cpl.“, ident. no. 386650Z, may only be used for the below stated heaters:

- Heater Thermo 230/231/300/301/350, with magnetic coil ident. no. 29313\_
- Heater DBW 230 (2020)/300/350 for 12 V, version with magnetic coil ident. no. 322083
- Heater DBW 230 (2020)/300/350/470 for 24 V, version with magnetic coil ident. no. 322091

**Otherwise the operation license of the heater will become invalid.**

**Spare parts note:** The new solenoid valve 2710806B, which was included into the heater series production, must be completely replaced if required.



**Old version of solenoid valve**

**New solenoid valve 2710806B**

prepared on 20.10.2008

### **Splash water protection of magnetic clutch pumps through technical changes**

**For all magnetic clutch pumps new / changed parts will be provided:**

- Shroud with changed design
- Additional gasket and a membrane
- The bearing splash guard is no longer used

**By means of these technical changes the pump is completely protected against splash water.**

**Affected are the Spheros circulation pumps U4818, U4854, U4856, as well as the spare part kits magnetic clutch and the spare part kits motor. The identification numbers of the items remain unchanged.**

### Shroud design changes

Shroud old



Shroud new





### New gasket and membrane

New gasket



New membrane



## Replacement of the solenoid valve at DBW and Thermo Heaters

### Old solenoid valve

DBW 12 V --> 322083 + 2710247A

DBW 24 V --> 322091 + 2710248A

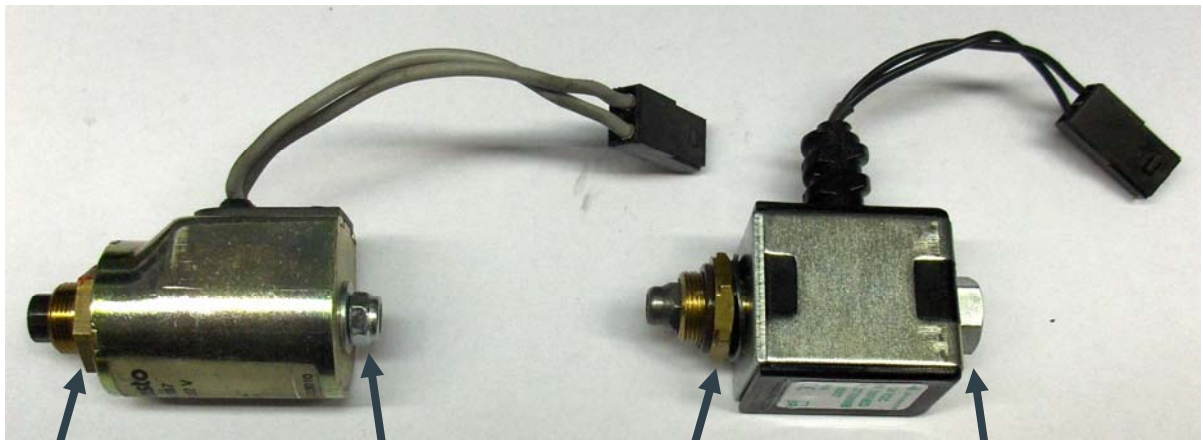
Thermo --> 29313\_

### New solenoid valve

2710808A

2710807A

2710806B



SW 16  
(11.5 Nm)

SW 8  
(2 Nm)

SW 16  
(5 Nm)

SW 12  
(1,5 Nm)

### NOTE:

To replace the solenoid valve, first loosen the nut SW 8 resp. SW 12 (ref. figure) and remove the coil body. Thereafter the armature sleeve SW 16 can be loosened more easily.

For installation reverse the sequence. Before installing the coil body, the armature sleeve must be tightened. Torque to 5 Nm. Then reinstall the coil body and fix it with the nut and torque as prescribed (ref. figure).

prepared on 16.12.2008

# Technical Information

## 01-2009

(supersedes TI 07-2008)



## Introduction of a new Electronic Ignition Unit and a new Spare Parts Kit for Thermo Heaters

The new electronic ignition unit 2710213A supersedes the previous version 14845C.

**Do not reuse the combination screws M5x16 with spring ring when replacing the old ignition unit 14845C by the new version 2710213A.**

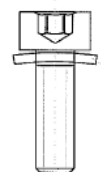
If required, please order in the future the **11113935A ignition unit spare parts kit**. It contains the ignition unit 2710213A and 2 ea 2710315A combination screw M5x16 (hexagon socket screw with conical spring washer).

The amendment index of the heaters / burners will not be increased. The implementation of the new ignition unit into the production is accomplished in the middle of January 2009.



2710213A

**The ignition unit 2710213A is to be installed with 2 combination screws M5x16 (hexagon socket screw with conical spring washer) only.**



2710315A

prepared on 26.01.2009

## Nozzle Block Preheater for Thermo Heaters - Installation Notes for Heating Element Retrofit -

**Spheros spare parts kit to be used:**  
**86711B – Retrofit bag heating element**

### Bag content:

- Heating element with thermostat
- Shield assy
- Retaining clamp
- Serrated lock washer
- Nut

### **Step 1:**

Remove installed  
shield

Further use delivered  
shield



prepared on 02.02.2009

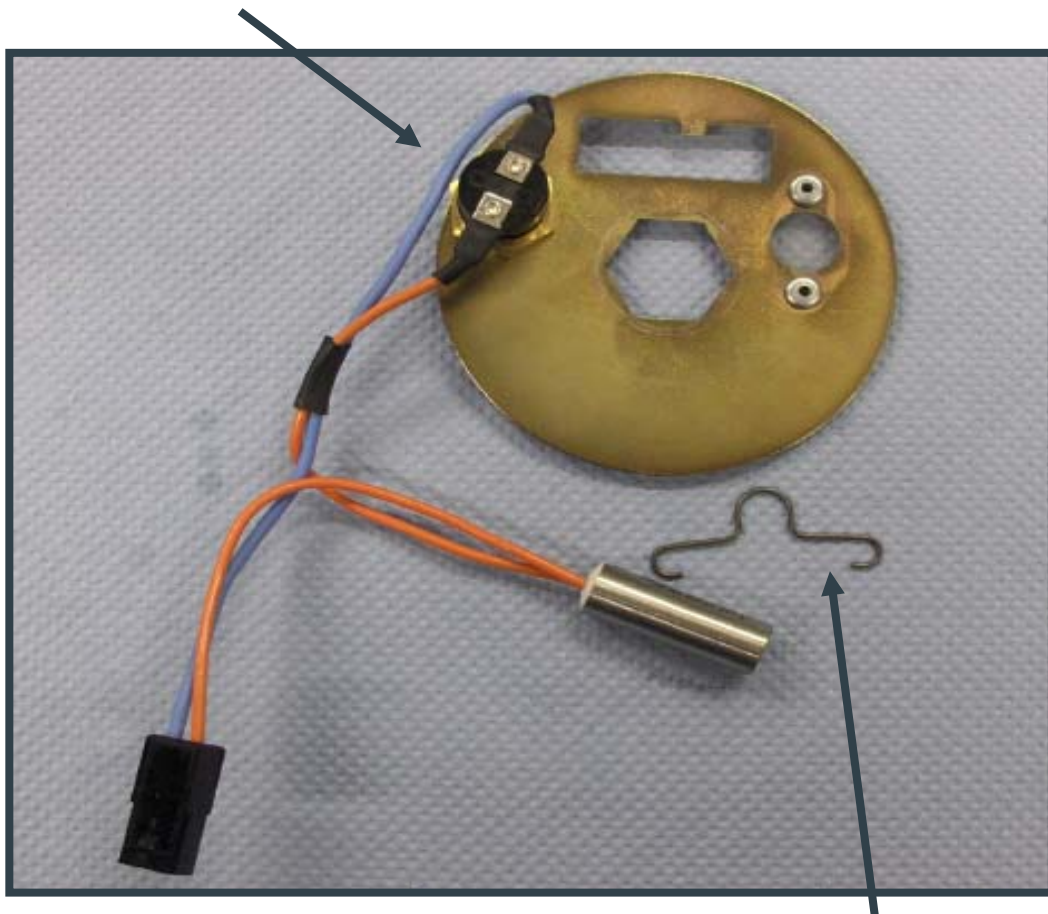
## Nozzle Block Preheater for Thermo Heaters - Installation Notes for Heating Element Retrofit -

### Step 2:

Shield pre-assembly:

**Position thermostat into the shield;**

**Install serrated lock washer and hand-tighten the nut.**



**For retaining clamp installation,  
refer to step 3.**



## Nozzle Block Preheater for Thermo Heaters - Installation Notes for Heating Element Retrofit -

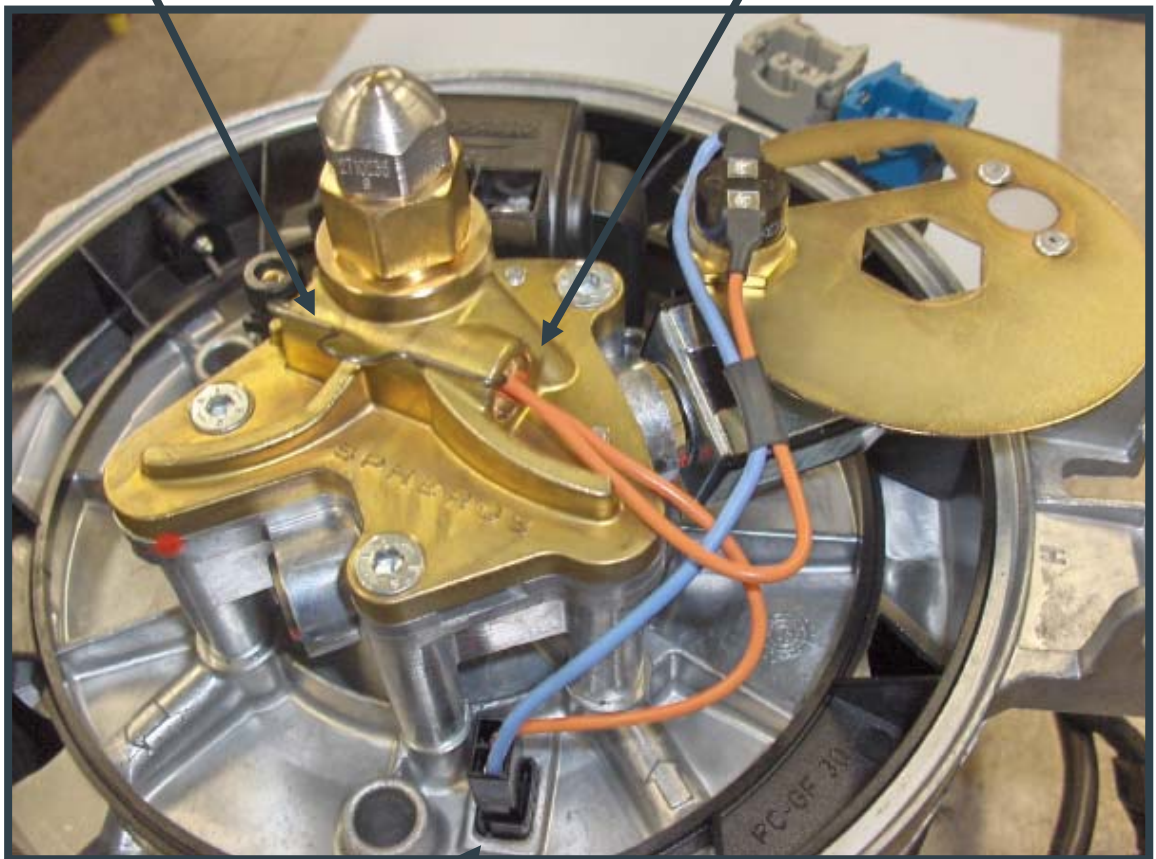
### Step 3:

#### Substep 2:

Secure the heating element with the retaining clamp

#### Substep 1:

Insert the heating element



#### Substep 3:

Remove dummy connector; plug in the new connector

## Nozzle Block Preheater for Thermo Heaters - Installation Notes for Heating Element Retrofit -

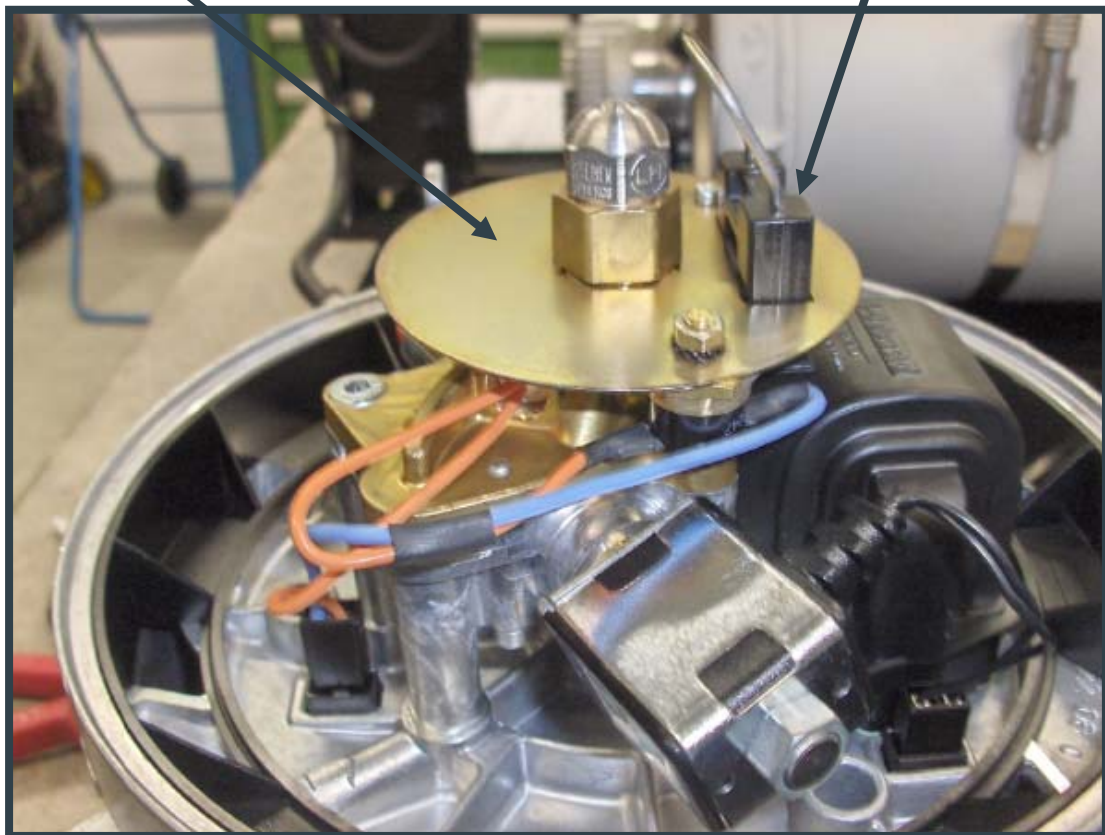
### Step 4:

#### Substep 1:

Place the pre-assembled shield onto the burner head and align it so the ignition electrodes can be plugged in.

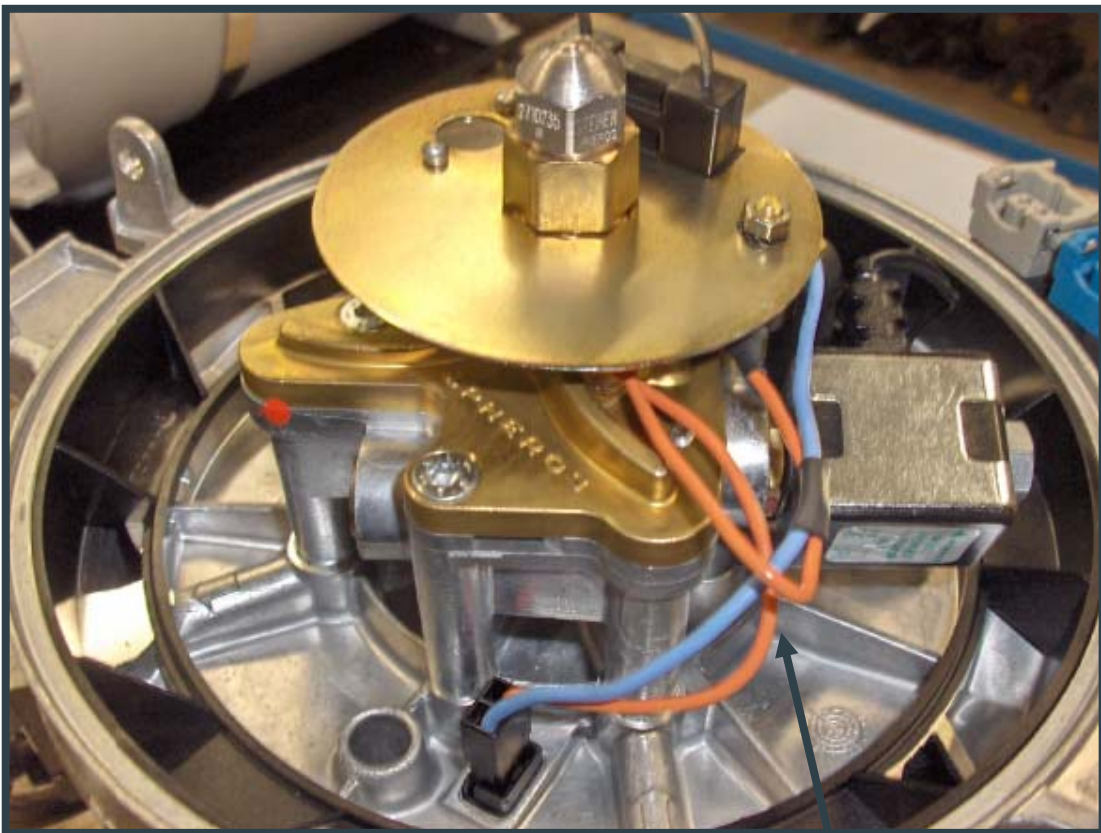
#### Substep 2:

Install ignition electrodes



## Nozzle Block Preheater for Thermo Heaters - Installation Notes for Heating Element Retrofit -

**Final result: Thermo heater with retrofitted heating element**



**Route cables as shown above**

### **Attention:**

**Please consider during all other activities done at the heater in regard to this retrofit the instructions given in the workshop manual.**

prepared on 02.02.2009



# Technical Information

## 04-2009

(supersedes TI 03-2008)



## Usage of new, optimized, downward compatible Spheros atomizing nozzles for Thermo Heaters

- Usage of hollow cone nozzles
- Selected for Spheros quality – optimized spray character / spray angle
- Below of emission limitation permitted per law
- Labeled with Spheros logo, heating power and identification number
- Warranty and product liability only if genuine parts are used
- Torque to  $20 \pm 2$  Nm;  
(when tightening or loosen the nozzle, support the nozzle holder)
- **New Spheros identification numbers for Thermo Heaters 30 / 35 kW:**
  - **2710235B** - atomizing nozzle 30 kW; (**470724** still valid for DBW Heaters)
  - **2710236B** - atomizing nozzle 35 kW; (**469556** still valid for DBW Heaters)
  - **470716 atomizing nozzle 23 kW (without label)**  
**still valid for Thermo and DBW Heaters**

Sample view



prepared on 29.04.2009

## New spare parts kit for the current Spheros fuel pump

Please consider the following:

For repair purposes of the current Spheros fuel pump 11112615A the new identification no. 11113051A (spare parts kit - gaskets) is to be used necessarily.

Content spare parts kit:

1 strainer Ø7,4-0,1 mm and 2 O-rings 7,65 x 1,78



---

For the previous fuel pump 82233A/B the 19977D (small parts fuel pump – bag 1 repair) resp. the 1302999B (small parts fuel pump – bag 2 installation) shall be further used.



Content kit 1 (standard repair kit - wear):

1 strainer Ø7,4-0,1 mm; 1 O-ring 5,28 x 1,78;  
1 O-ring 7,65 x 1,78



Content kit 2 (assembly kit – for nozzle holder sealing):

2 torx screws M4x12; 1 torx screw M4x20;  
1 O-ring 2,9 x 1,78; 1 O-ring 33,08 x 1,78;  
assembly instruction

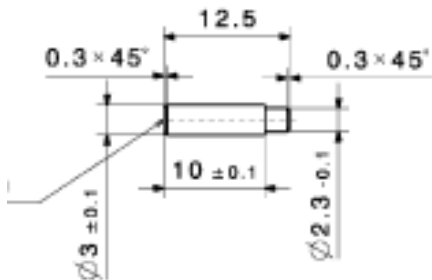


### New Spheros ident. no. for „Small parts for magnetic coil“

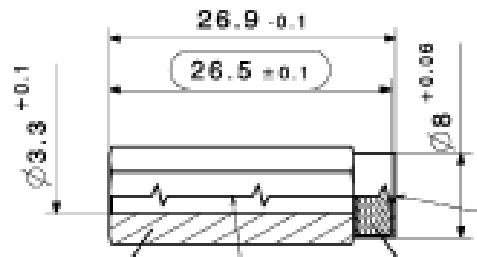
As of now, the spare parts kit „Small parts for magnetic coil“ can be ordered only, using the new Spheros ident. no. 11113599B (previously 386650Z).

The bag content remains unchanged, solely the package was adapted.

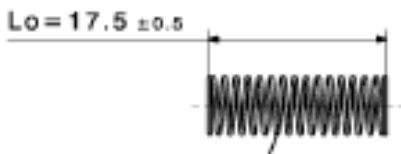
Pin



Armature cpl.



Pressure spring



O-ring



Please consider the Technical Information 04-2008 when using the „Small parts for magnetic coil“.

# Technical Information 02-2010

## New Fuel Pumps for Thermo Heaters



Pumps to be replaced - Ident. No.	Application	New Ident. Numbers	Conversion kit to be ordered if required
<b>82233A/B</b> (only two-pipe operation)	without heating element	pump: 11114892A	<b>11112778B</b>
	with "heating element with thermostat" 83933B	pump: 11114892A heating element with thermostat: 83933C	<b>11112779B</b>
	as vertical burner (only Thermo 231.001 + 301.001)	pump: 11114892A thermostat: 98640B (for <u>vertical burners</u> )	<b>11112780B</b>
<b>11112615A</b> (two-pipe operation)	without heating element	pump: 11114892A	<b>11112778B</b>
	with "heating element with thermostat" 83933C	pump: 11114892A ( <u>continue to use</u> the heating element 83933C)	<b>11112778B</b>
	as vertical burner (only Thermo 231.001 + 301.001)	pump: 11114892A ( <u>continue to use</u> the thermostat 98640B)	<b>11112778B</b>
<b>11112615A</b> (single-pipe operation)	only heater Thermo 230.060	pump: 11114957A ( <u>continue to use</u> the heating element 83933C and thermostat 98640B)	<b>11114941A</b>
<b>97952A/B/C</b> (only single-pipe operation)		pump: 11114957A (heating element 83933C and thermostat 98640B incl. <u>shipment</u> )	<b>11114992A</b>
<b>11114003A</b>	only heater Thermo 350.190	pump: 11114893A	<b>11115017A</b>

prepared on 18.11.2010

### Heater reset after a lock-out and fault analysis

In the context of product quality monitoring and quality analysis we increased note the submission of control devices which are ok (without any findings) in our plant in Neubrandenburg.

Against this backdrop, we would like to advice you, that the deletion of saved faults by the Spheros Thermo Test Diagnosis (ID. 11112249A) will not automatically remove the heater / control device fault lock-out too.

To remove the heater fault lock-out the related instructions of the appropriate Thermo / Thermo S Workshop Manual should be considered (see [www.spheros.de/Service.Technische\\_Dokumente.Heizsysteme.aspx](http://www.spheros.de/Service.Technische_Dokumente.Heizsysteme.aspx)).

In this way you avoid unnecessary disassemblies and the respective effort (working time, shipment, etc.).

Please note that the removal of the heater fault lock-out shall be accomplished by trained personnel only. That includes also an investigation of the cause of the heater fault lock-out. In order to process complaints faster and more efficient, please consider that the control devices our heaters save the error codes. These codes then can be read out by the Spheros Thermo Test Diagnosis and saved as text file.

Please attach this text file to your return consignment.

In this manner you support a purposeful and fast error code analysis as well the fault remedy.